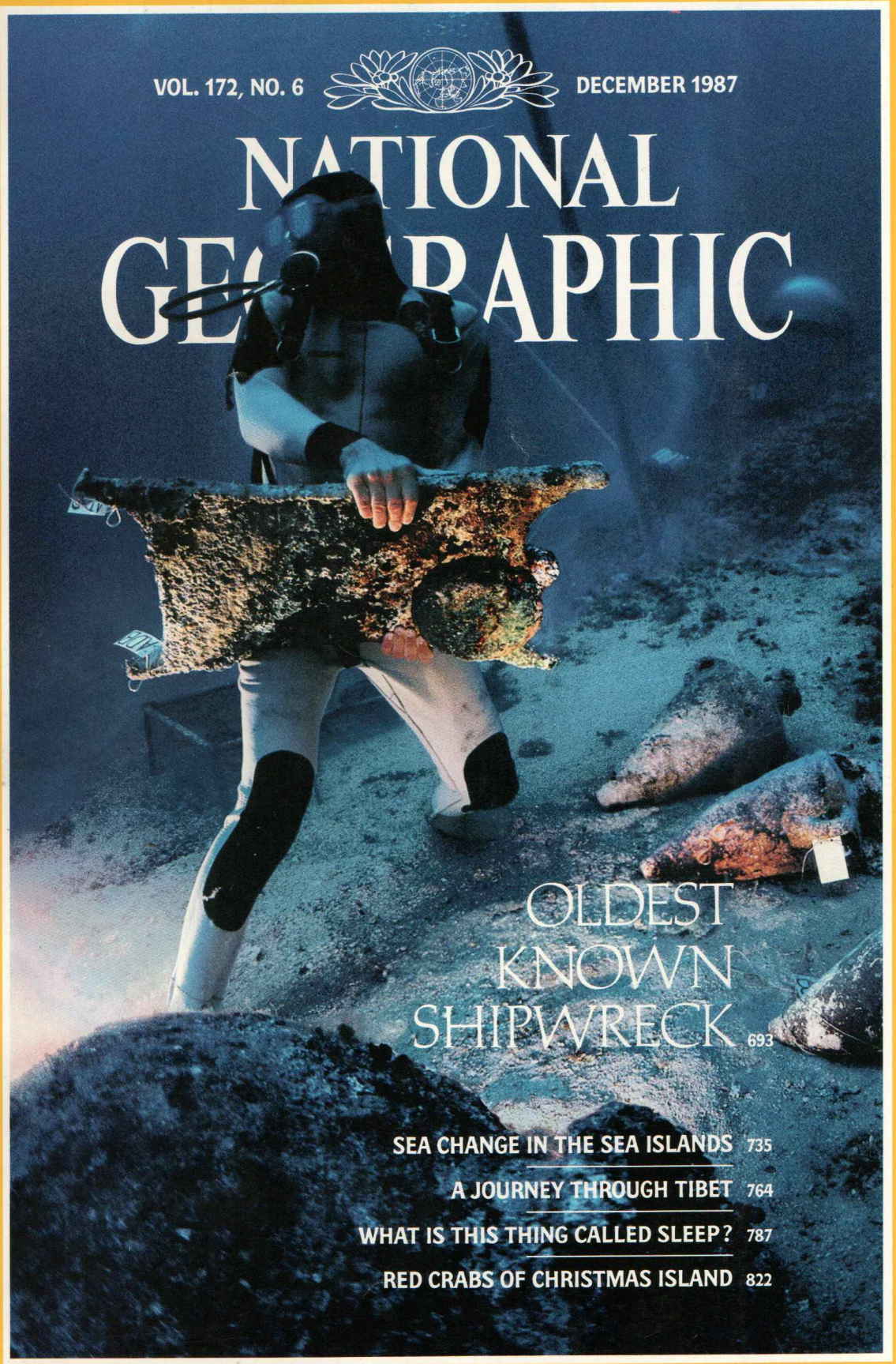
VOL. 172, NO. 6 DECEMBER 1987

NATIONAL GEOGRAPHIC



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RED CRABS OF CHRISTMAS ISLAND 822

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

NATIONAL GEOGRAPHIC DECEMBER 1987
BRONZE AGE WRECK SEA ISLANDS TIBET TREK SLEEP RED CRABS

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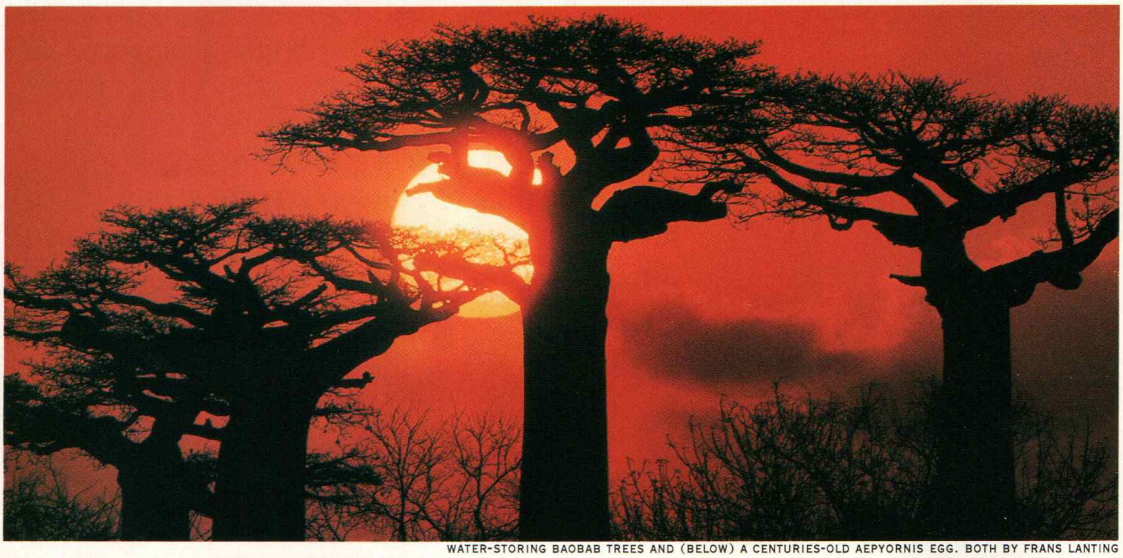
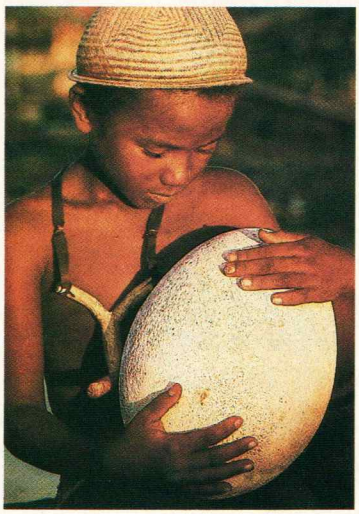
Madagascar: a lot to lose



WATER-STORING BAOBAB TREES AND (BELOW) A CENTURIES-OLD AEPYORNIS EGG. BOTH BY FRANS LANTING

IMAGINE A BIRD that stands ten feet tall, weighs half a ton, and lays twenty-pound eggs. Such a bird once existed on the island of Madagascar—and not so long ago.

The "elephant bird," or *Aepyornis,* vanished from Madagascar about 500 years ago. Scientists can't explain yet what killed it off, along with giant lemurs, giant tortoises, and pygmy hippos. It may have been a sudden shift in climate, compounded by the arrival of humans on the island 1,500 years ago. But whatever the cause, their loss makes even more frightening the prospect of new extinctions there today.



Isolated for 165 million years, this mini-continent was called a "living laboratory for evolution" in a February 1987 GEOGRAPHIC article by zoologist Alison Jolly. And yet, in only 35 years, nearly half its forests, sheltering countless unique species of plants and animals, have been destroyed for farmland and fuel by a desperately poor population.

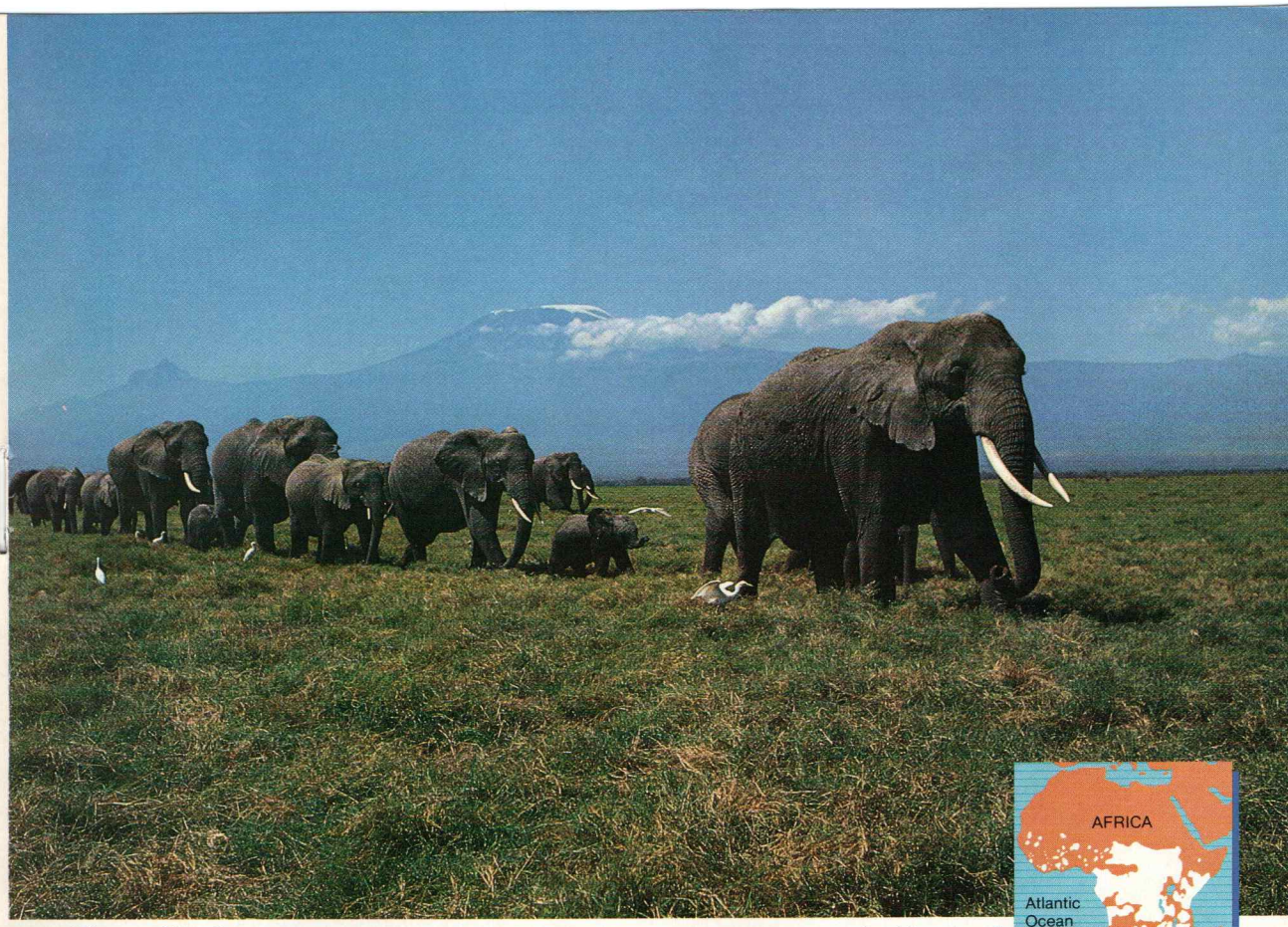
In the past the government of Madagascar was reluctant to admit foreign scientists to the island. But now it has opened the door to researchers, a number of whom are aided by your Society.

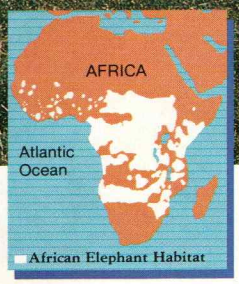
Among the projects we help support: expeditions to identify and collect specimens in eastern rain forests and in the spiny desert; a satellite survey to aid in conservation planning; studies of lemurs, among the most primitive of primates. The World Wildlife Fund and other groups are sponsoring similar projects.

Can Madagascar avoid a new wave of extinctions? Maybe. Severe poverty still grips the island's ten million people, and projections of continued forest losses are gloomy. But if there is a turnaround, it will happen because of a commitment by the Malagasy government to protect the country's natural treasures.

Gilbert M. Grosvenor

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY





African Elephant **Genus:** *Loxodonta* **Species:** *africana* **Adult size:** Length of head and body, male, 6-7.5m; female, 0.6m shorter; height, male, 3.3m; female, 2.4m **Adult weight:** Male, up to 6,000kg; female, 3,000kg **Habitat:** Savanna grassland and forest south of the Sahara **Surviving number:** Estimated at less than 1 million Photographed by Cynthia Moss

Wildlife as Canon sees it

One of the greatest roles of photography is to record and preserve images of the world around us worthy to be handed down as a heritage for all generations. A photograph of a family of African elephants peacefully crossing a wide-open grassland provides a memorable image that exemplifies the grandeur of the species.

Recent studies have revealed elephants to be the first land mammals known to communicate through infrasound. Learning more about this means of communication and their complex and highly structured social behavior could benefit the elephants' chances for survival. Unfortunately, elephant populations are declining rapidly due to poaching for valuable ivory. Stronger measures are required to control the killing of the animals in protected areas and stop the illegal ivory trade.

An invaluable research tool now being used in the long-term study of elephants, photography can contribute to a better understanding of the species and help promote an awareness of the urgent need for greater efforts to protect this magnificent and irreplaceable part of our natural heritage.

And understanding is perhaps the single most important factor in saving the African elephant and all of wildlife.

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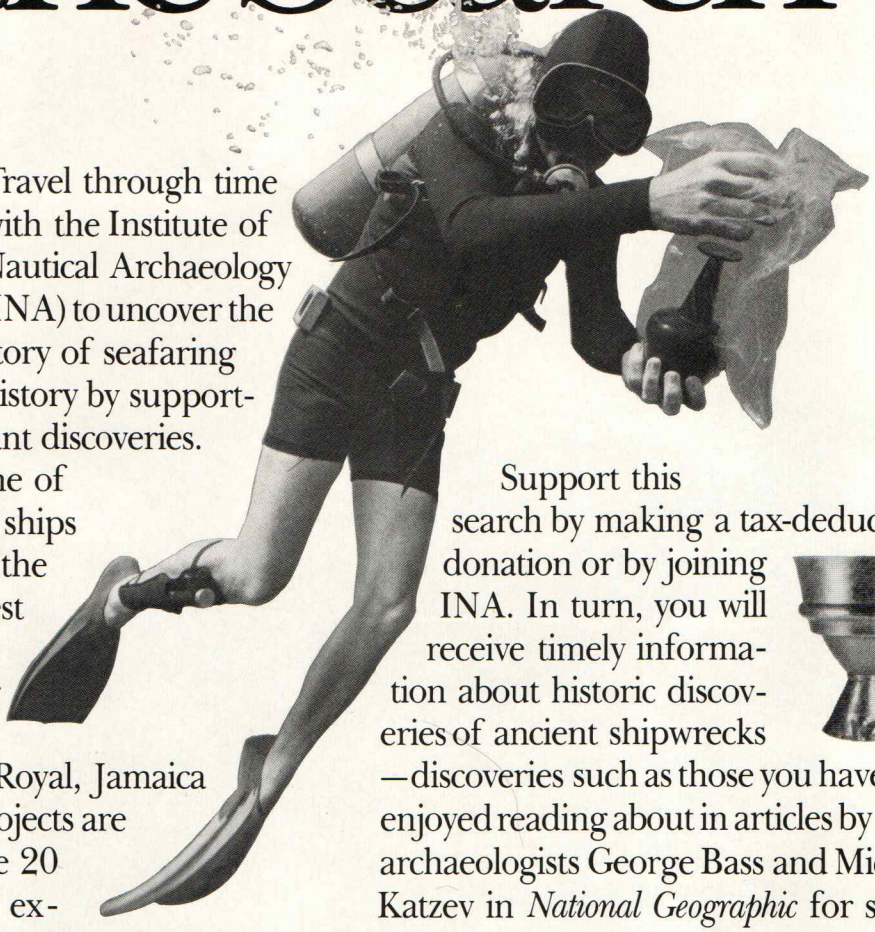
These projects are among some 20 underwater explorations that have been undertaken by scientists from INA, a nonprofit scientific and educational organization. By studying the great shipwrecks of the past, INA researchers have uncovered history dating back 3,600 years.



Support this search by making a tax-deductible donation or by joining INA. In turn, you will receive timely information about historic discoveries of ancient shipwrecks —discoveries such as those you have enjoyed reading about in articles by INA archaeologists George Bass and Michael Katzev in *National Geographic* for some 25 years.

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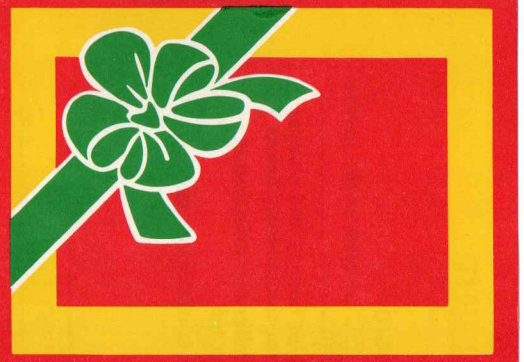

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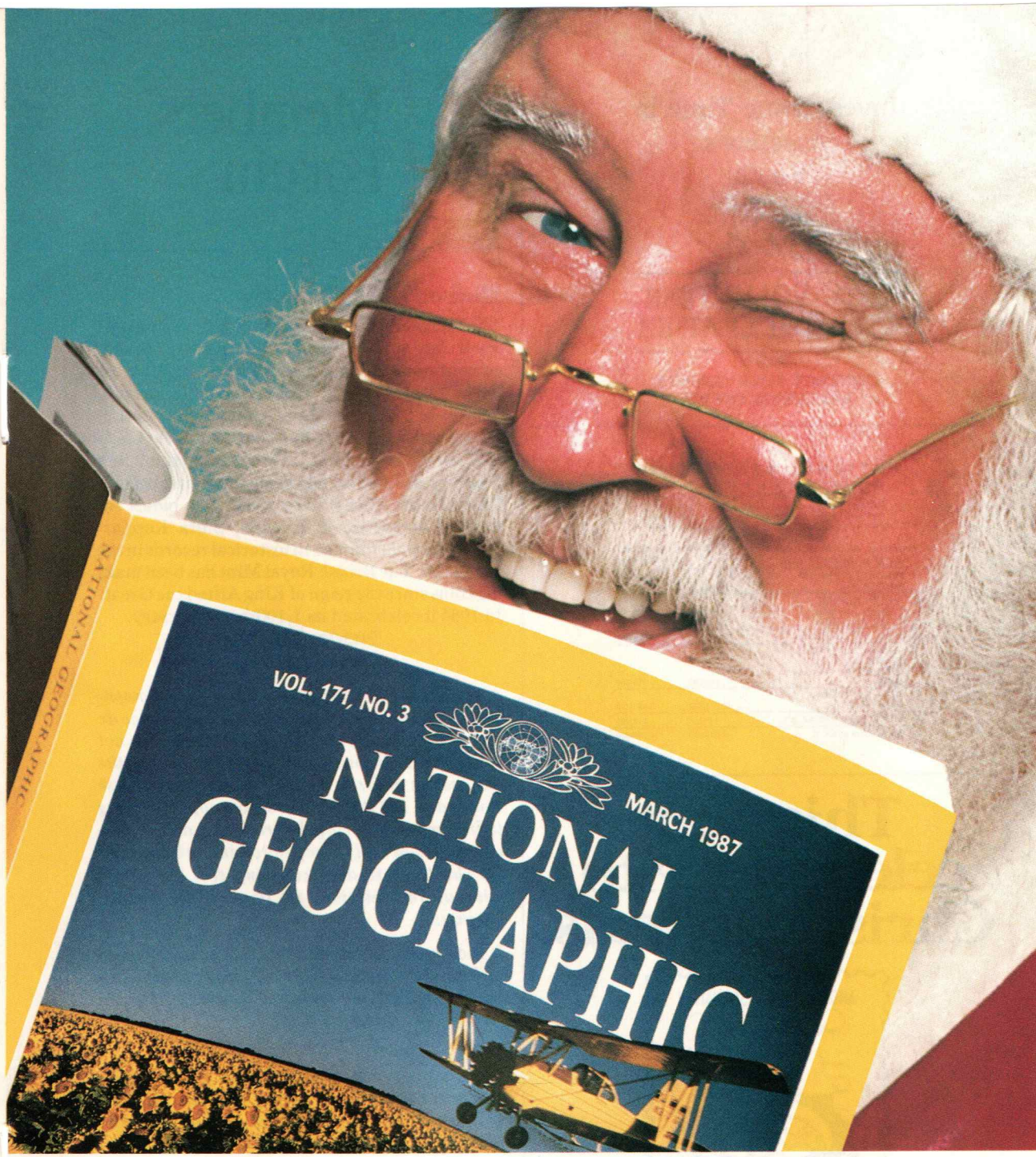

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Members Forum

Hudson's Bay Company

The Hudson's Bay Company, which received its royal charter in 1670, was described as "the oldest continuous commercial enterprise still in existence" (August 1987). This is a difficult claim to justify. In France the Saint-Gobain glass undertaking was established by a charter of King Louis XIV in October 1665. The Whitechapel Bell Foundry in London has been supplying bells to Westminster Abbey since 1583. The oldest industrial enterprise in Sweden, Stora Kopparberg, is first mentioned in historical records in the year 1288. The British Royal Mint has been making coins since the reign of King Alfred the Great. In 1986 it celebrated its 1,100th anniversary.

HENRY G. BUTTON
Cambridge, England

A number of other businesses, such as the Lowenbrau brewery in Munich (1383) and the Banco de Napoli (1539), are also older, but they have not maintained an unbroken operation under the same name or form. Stora Kopparberg is a close contender, but it has shifted from copper mining to iron manufacturing, hydropower, and chemicals. Hudson's Bay Company claims to be the oldest chartered trading *company still operating, without interruption, in its original line of business.*

It saddened me to realize that even in the harsh and desolate region of Hudson Bay animals can not find refuge from man's cruelty and greed.

RITA ZIZAK
Little Falls, New Jersey

In my job as a forest ranger I often deal with and confront trappers on a variety of issues. Because of tougher legislation and enforcement, new trap designs, and trapper education, the fur industry is more conservation minded, more humane, and more economically stable than in the early days of the Hudson's Bay Company. I find the trappers themselves to be as rugged, independent, and at home in the remote north as they were in the 1700s.

CHRISTOPHER G. MAHER
Petawawa, Ontario

Kevin Fleming's photograph of the Alexander Mackenzie inscription (page 218) is the best we've seen. The rock and monument, however, are not "beside the Bella Coola River" but at salt

water in Dean Channel, 50 kilometers northwest. And Mackenzie's original art, executed "in vermillion and melted grease," is lost; we have only this 1926 engraving by the Historic Sites and Monuments Board of Canada. Mackenzie's 350-kilometer overland trek from the Fraser River to the Bella Coola Valley has just been designated a Provincial Heritage Site, a route complementary to your Lewis and Clark Trail.

JOHN WOODWORTH
Kelowna, British Columbia

I'm in the fur business and deal with the Hudson's Bay Company. The furs on page 214 are not lynx; they're coyote.

JOHN CONTE
Herkimer, New York

You are right. The tags on the pelts in the photograph clearly say coyote. We missed it.

Sahel

I was moved to tears by your cover picture (August 1987) of the poor, wretched child from Mali. Isn't there anything we can do to help him?

KEN BURROWS
Boise, Idaho

We know of no way to get financial assistance directly to this boy. The photograph was made in a rural area where there are few outside visitors. However, addresses of relief organizations may be obtained through churches or libraries in your area. One such organization is CARE, 660 First Avenue, New York, New York 10016.

When the media stopped covering the African famine, people forgot about it, mistaking, as the author put it, "remission of crisis" for "recovery." When the public stopped demanding action, our legislators also forgot about Africa. As your article points out, Africa is far from recovered. More can be done at the village level. UNICEF has do-able, affordable steps to cut child death rates in half by 1990. The UN's International Fund for Agricultural Development (IFAD) has a special project for sub-Saharan Africa aimed at creating self-sufficiency for rural people. What we can do is urge our legislators to support UNICEF, IFAD, primary health-care measures, and the organizations named in the article. "Compassion fatigue" isn't fatal—but in the Third World malnutrition, simple diarrhea, and measles are.

PAT BARTON
Tulsa, Oklahoma

Personally, I would be willing to forgo some of NATIONAL GEOGRAPHIC's acclaimed photography if someone—preferably your photographer—would have brushed that "cluster of flies" off misery's child (pages 168-9).

M. L. EDWARDS
Gary, Indiana

The article was excellent in outlining the problems faced by the people. In Chad and Mauritania I saw very effective agricultural programs: Granaries were being built to help people store food, pesticide spraying was combating locusts, and other programs, while small in scale, were helping change the lives of nomads and villagers. Your author does a disservice and contributes to the "donor fatigue," which he knows is undermining the efforts of nongovernmental agencies, when he suggests that little is being accomplished. The challenge now is to convince donors in Canada and the United States that their contributions are making a difference.

GRANT CASSIDY
World Vision Canada
Mississauga, Ontario

Alaskan Moose

I find it ridiculous that biologist Jim Rearden (August 1987) would say that man has to intervene to keep wolves from killing off the moose. I think that maybe nature knows better how to keep animal populations in balance.

TANYA LIVSHULTZ
Skokie, Illinois

Indianapolis

Congratulations on your portrayal of Indianapolis (August 1987). Although a midwestern city without mountains or coastlines, it has a simple beauty of its own. Your highlights of the renovated downtown section of the Hoosier capital were right on target. However, urban development has superseded the needs of the poor and the uneducated. Our city pours money into sports facilities and shopping malls but ignores our public schools. We may be "on the rebound," but we need to examine our direction.

KATHLEEN A. BERRY
Indianapolis, Indiana

Portraying Indianapolis as a town of poor jobless people being disregarded for the building of sports facilities, etc., was unfair and not totally accurate. I remember seeing drunks and broken windows in empty buildings where the convention center and the Hoosier Dome are now; that's improvement. I remember beautiful old houses near the James Whitcomb Riley home, run down and divided into apartments; people then began buying and fixing up those houses. The downtown was dead after 5 p.m.; now people want to be there for enjoyment.

Even poorer neighborhoods got together and pitched in to help each other paint, mend porches, make new sidewalks, and take pride in what they were doing themselves. Give credit to that! Soap and elbow grease go a long way.

JANE PRESTON
Hartford City, Indiana

It was unfair to include the American Legion with other "profoundly conservative" groups such as the John Birch Society and the Ku Klux Klan. Legionnaires as diverse as Edward Kennedy and Ronald Reagan belong to a politically nonpartisan organization that is mandated by our constitution to "combat the autocracy of both the classes and the masses." Our volunteers give millions of hours to programs ranging from infant hearing assessment to the tragedies of child abuse and teenage suicide. We are proud that Indiana provides a home for our national headquarters.

JAMES P. DEAN
Former National Commander
American Legion

A progressive Indianapolis for sure. But Indianapolis without Booth Tarkington is like Hannibal, Missouri, without Mark Twain. James Whitcomb Riley got four mentions to the disdainful chagrin of Penrod, Alice Adams, Willie Baxter, the magnificent Ambersons, and the elegant Monsieur Beaucaire.

SMITH W. MOSELEY
Birmingham, Alabama

Kathmandu Valley

I read your story on Kathmandu (July 1987) with special interest since I am a Peace Corps volunteer working there. You indicate in the caption on page 55 that the Garuda statue shown has

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"unfortunately been half-buried by successive layers of pavement." My Nepalese friends believe that the opposite is happening, that the statue is slowly rising out of the ground, and when the statue comes completely out, the world will end. My friends' grandparents say that only the head was showing when they were young.

BRYAN THORESON
Kathmandu, Nepal

Immune System

How is Dan Turner of San Francisco (June 1986) doing in his battle against AIDS?

GARY M. HARRISON
Reno, Nevada

Dan Turner reports that he is doing well. Doctors at the University of California at San Francisco are trying to determine why his immune system, unlike those of other patients, has been able to hold the AIDS virus at bay.

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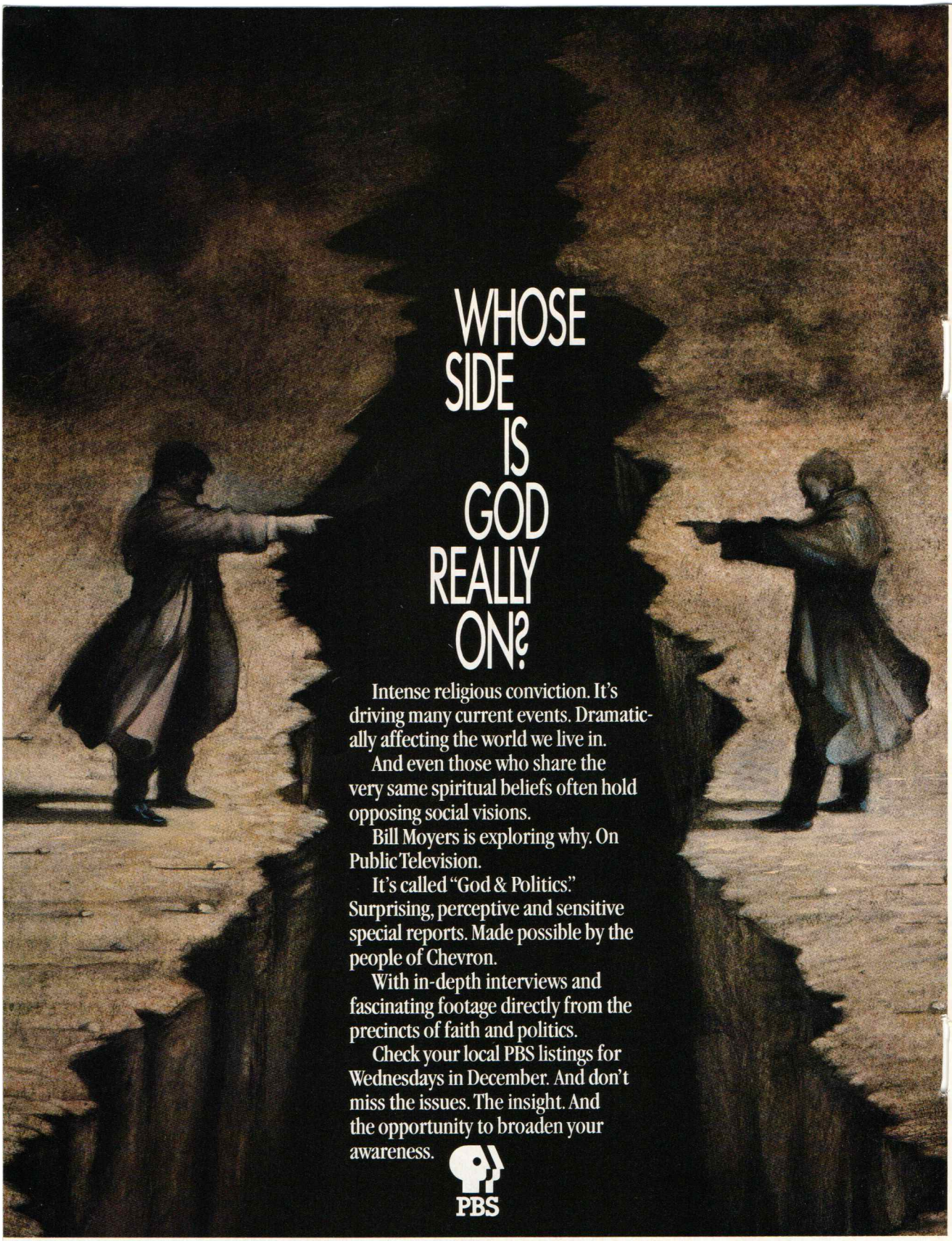
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As THE National Geographic Society ends its hundredth year with this issue, it's appropriate that we lead with a report of an important archaeological discovery funded in part by your dues. Such a study would have been impossible a hundred years ago, but it is just as adventurous and dangerous as any we have ever reported, for it involves an ancient shipwreck lying 140 to 170 feet down on the Mediterranean floor. Always at risk at this depth, Turkish and U. S. scientists and students have excavated as meticulously as on any land site. Man's knowledge of the Bronze Age takes a great leap forward as a result.

Last summer another group drew fire for retrieving objects from another important shipwreck—the R.M.S. *Titanic*. A French team backed by investors led by a former U. S. car dealer was accused of looting the site. Columnist William F. Buckley, Jr., represents the view that salvaging *Titanic* memorabilia is justified as "retrieving from utter uselessness artifacts that, for some people, exercise an alluring historical appeal." For me their appeal was dramatically diminished when those objects—commercially valuable as they may be—were removed for glass-case display.

If everybody who admires the Great Wall of China took one stone home as a souvenir, there would soon be no Great Wall, and the stones would be just tragic reminders of what was.

Just as not all old buildings and monuments should be saved, not all shipwrecks should be inviolate, but the *Titanic* has become an icon; it is the Cheops Pyramid of shipwrecks. It has become a symbol of man's arrogant trust in technology, a monument to an era of opulence and ostentatiousness and to an elegant way of travel long since replaced by airplanes.

Though submarine technology someday will permit tours of the site and extended archaeological study, a case can be made for satisfying curiosity now and making a few bucks by displaying *Titanic* objects. However, a better case can be made for leaving them undisturbed. The Senate obviously thought so in voting to bar their sale or display for profit in the U. S. To paraphrase a sign seen in many national parks: "Take only photographs, leave *no* footprints."

That the *Titanic* wreck is a reasonably recent artifact makes it no less historic, and that it may contain valuable jewels makes it no less a monument that should be protected from all but the slow natural erosion of the sea that claimed it.

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

DECEMBER 1987

Oldest Known Shipwreck Reveals Bronze Age Splendors 693

Sailing an ancient trade network, a ship sank off Turkey some 3,400 years ago. Now marine archaeologist George F. Bass excavates and, with photographer Bill Curtsinger, reports on an unprecedented trove of pottery, weapons, and copper and tin ingots.

Sea Change in the Sea Islands 735

Cultural traditions brought from Africa and a Creole language called Gullah erode under the impact of resort development along the South Carolina and Georgia coast, Charles L. Blockson finds. Photographs by Karen Kasmauski.

Nomads' Land: A Journey Through Tibet 764

Sorrel Wilby, a young Australian, walks 1,800 miles across western Tibet and gets more than she bargained for in snow blindness, blisters, and understanding.

What Is This Thing Called Sleep? 787

Familiar yet mysterious, sleep still baffles the experts. Michael E. Long and photographer Louie Psihoyos investigate crib death, breathing disorders, nightmares, narcolepsy, and other ailments that make sleep hazardous to your health.

Red Crabs of Christmas Island 822

Swarming over a tiny island in the Indian Ocean, millions of crustaceans undertake an annual march to the sea, tidying the landscape and invading houses along their route. By conservationist John W. Hicks.

COVER: *Raw material of the Bronze Age, a four-handled copper ingot concreted to a round one is removed by an archaeologist off Turkey from the site of the world's oldest shipwreck yet found. Photograph by Bill Curtsinger.*

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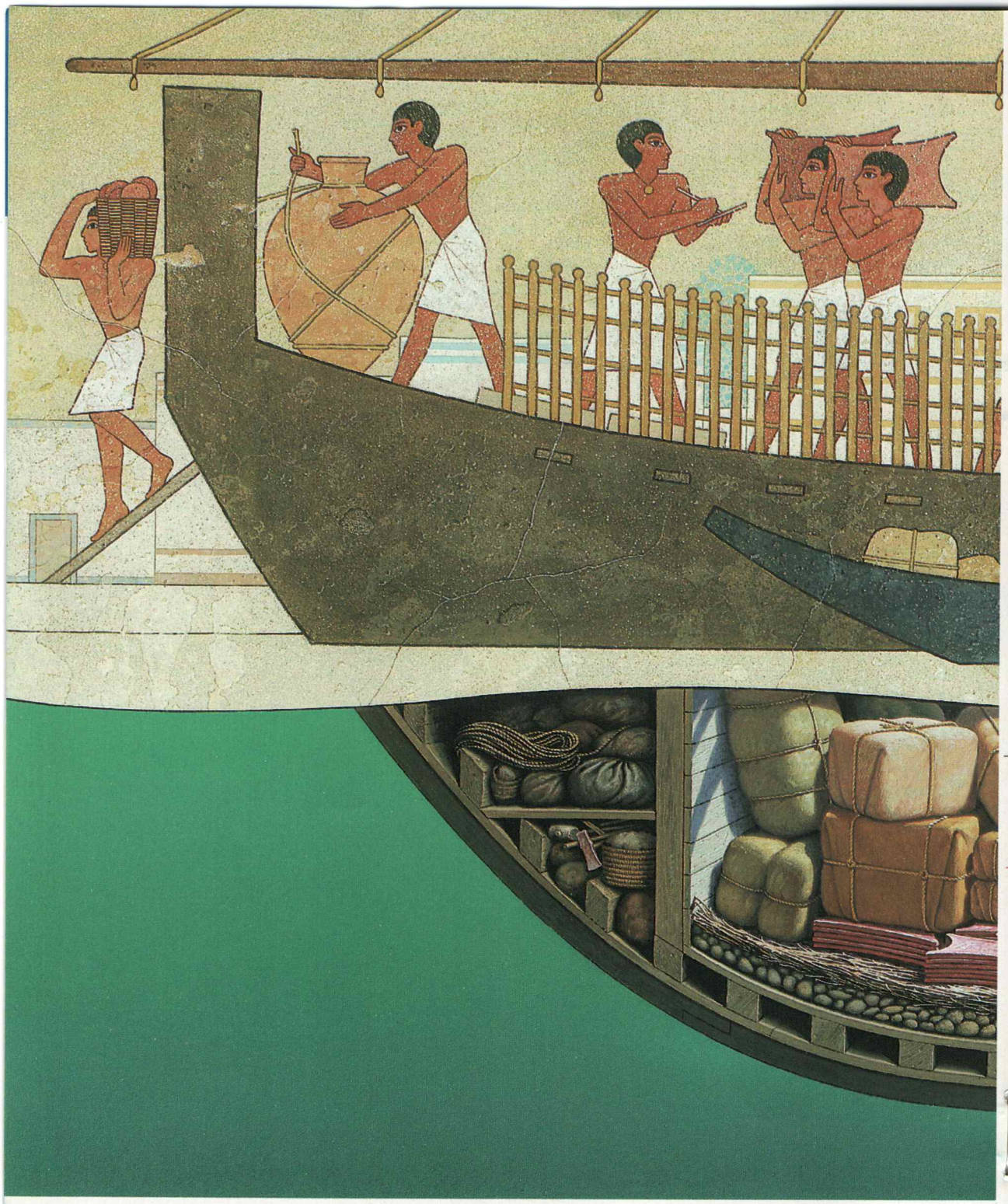
Oldest Known Shipwreck Reveals

SPLENDORS OF THE BRONZE AGE

Golden wings outstretched, a falcon adorns the face of a Bronze Age pendant. The priceless relic, probably of Canaanite design, was recovered from a 14th-century B.C. trading vessel lost off the Turkish coast, at Ulu Burun. At a depth of 150 feet a Turkish excavator (left) cleans debris from one of some 200 four-handled copper ingots retrieved from the wreck's cargo, which represents seven civilizations that flourished in the eastern Mediterranean area in Late Bronze Age times. Thousands of other items provide an astonishing portrait of an era symbolized by the reign of Egypt's Tutankhamun and the fall of Troy.

By GEORGE F. BASS
Photographs by BILL CURTSINGER

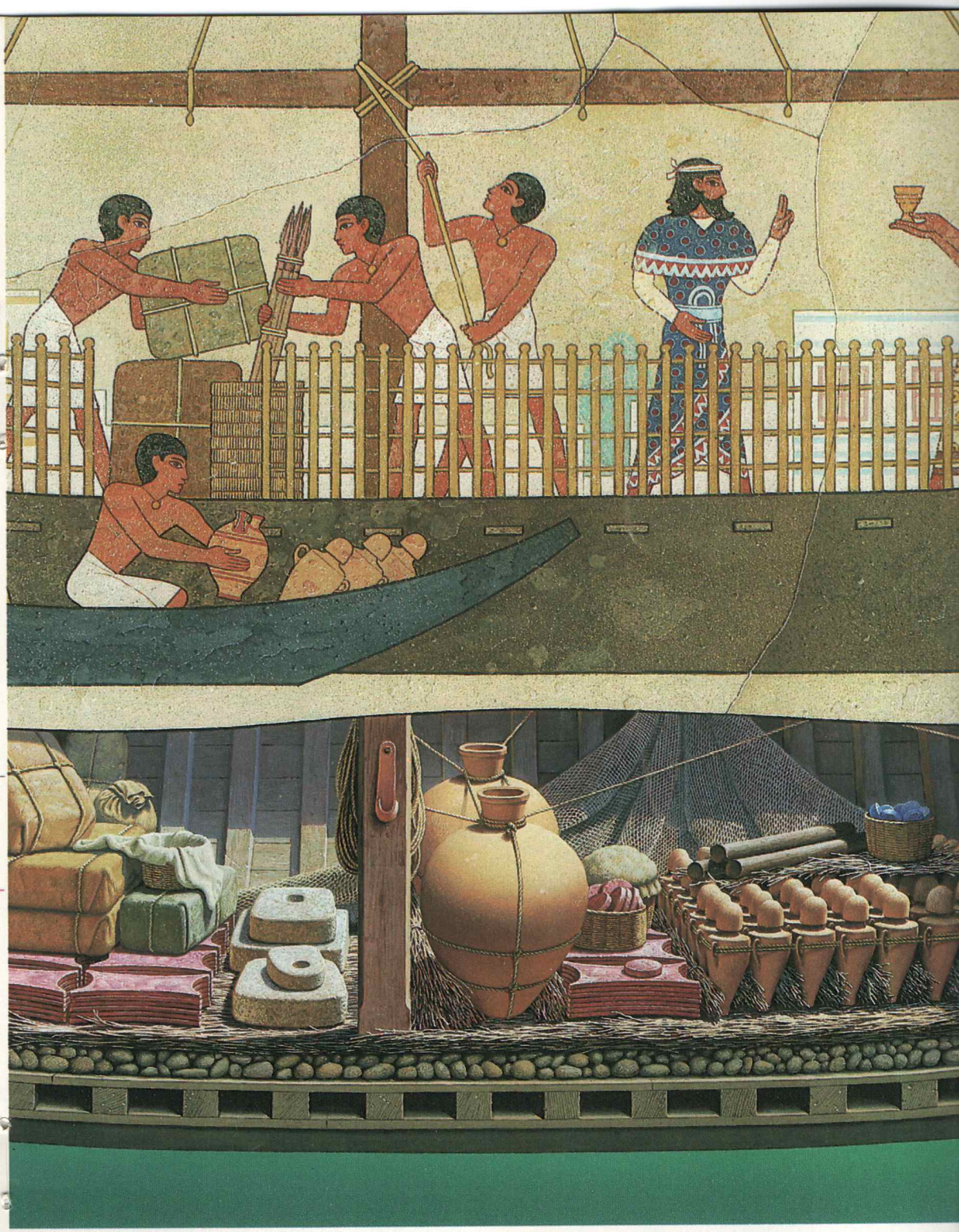
DONALD FREY



First look at a merchantman 34 centuries old

IT WAS A STAGGERING LOSS when this 50-foot vessel, laden with valuable goods and vital commodities from around the Mediterranean and beyond, sank near the sheer promontory called Ulu Burun. But now it has become a find of tremendous significance for the author's team from the Institute of Nautical Archaeology (INA) in Texas.

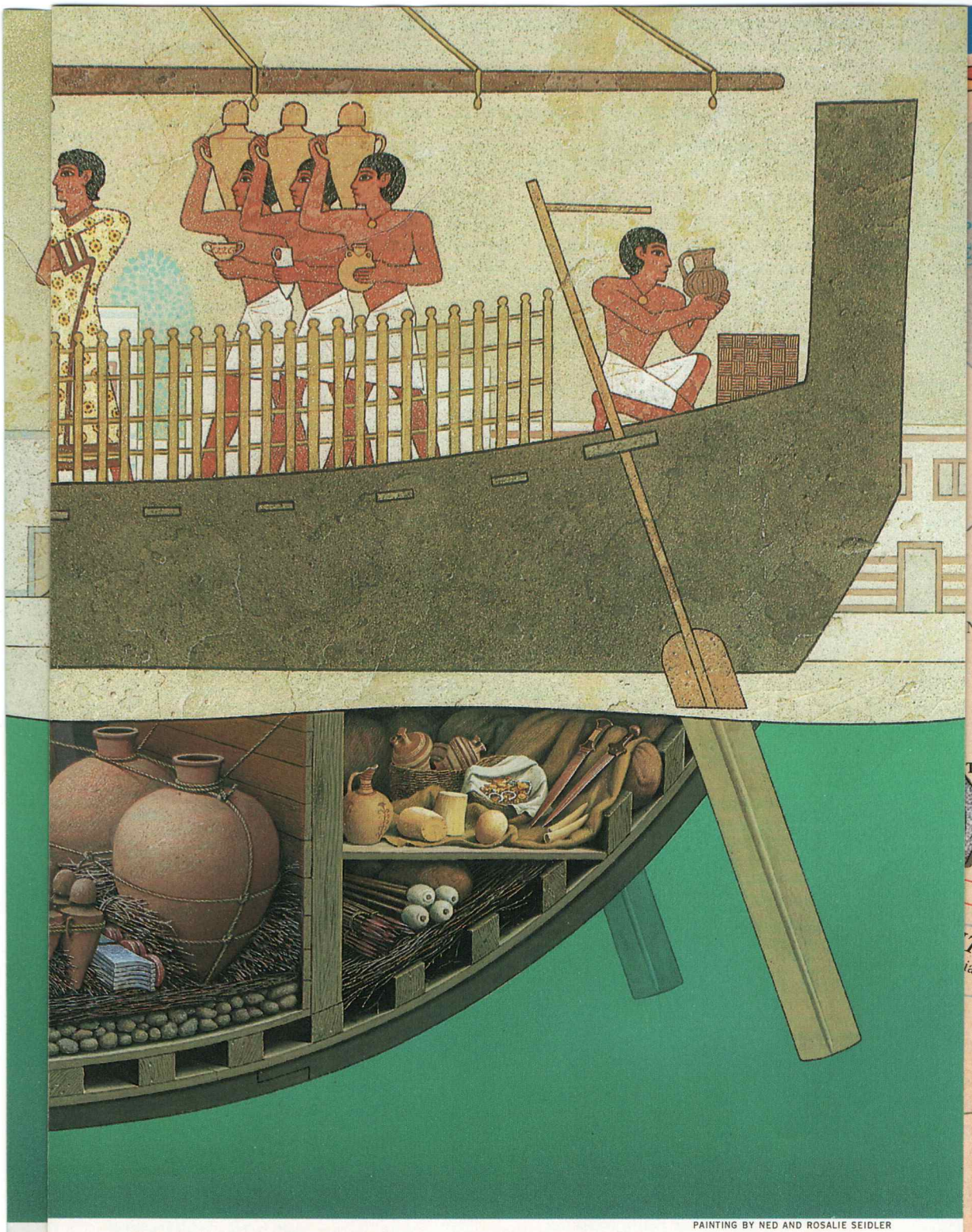
Since a Turkish sponge diver first located a trove of ingots on the seabed in 1982, the INA team has spent four years excavating and studying the vessel, developing an idea of how she may have looked in life. Elements of the ship



above the waterline are based on a 14th-century B.C. Egyptian tomb painting showing the arrival of a Syrian fleet. Cargo is based on items recovered from the wreck.

An immense storage jar, called a *pithos,* awaits unloading, at left. Raw materials of the Late Bronze Age, four-handled ingots of copper were melted with tin to make bronze tools and weapons, such as spearheads unpacked amidships. A bearded Canaanite merchant and a Mycenaean Greek admire a gold chalice. Those two nationalities, as well as Cypriot, are possible for the vessel, whose origin is still uncertain. The crew may have been a mix of cultures.

Unlike the vessel's upper features, which have dissolved, some of those below the waterline have been preserved by sediment, and precise mapping takes over from archaeological speculation. Hull planks

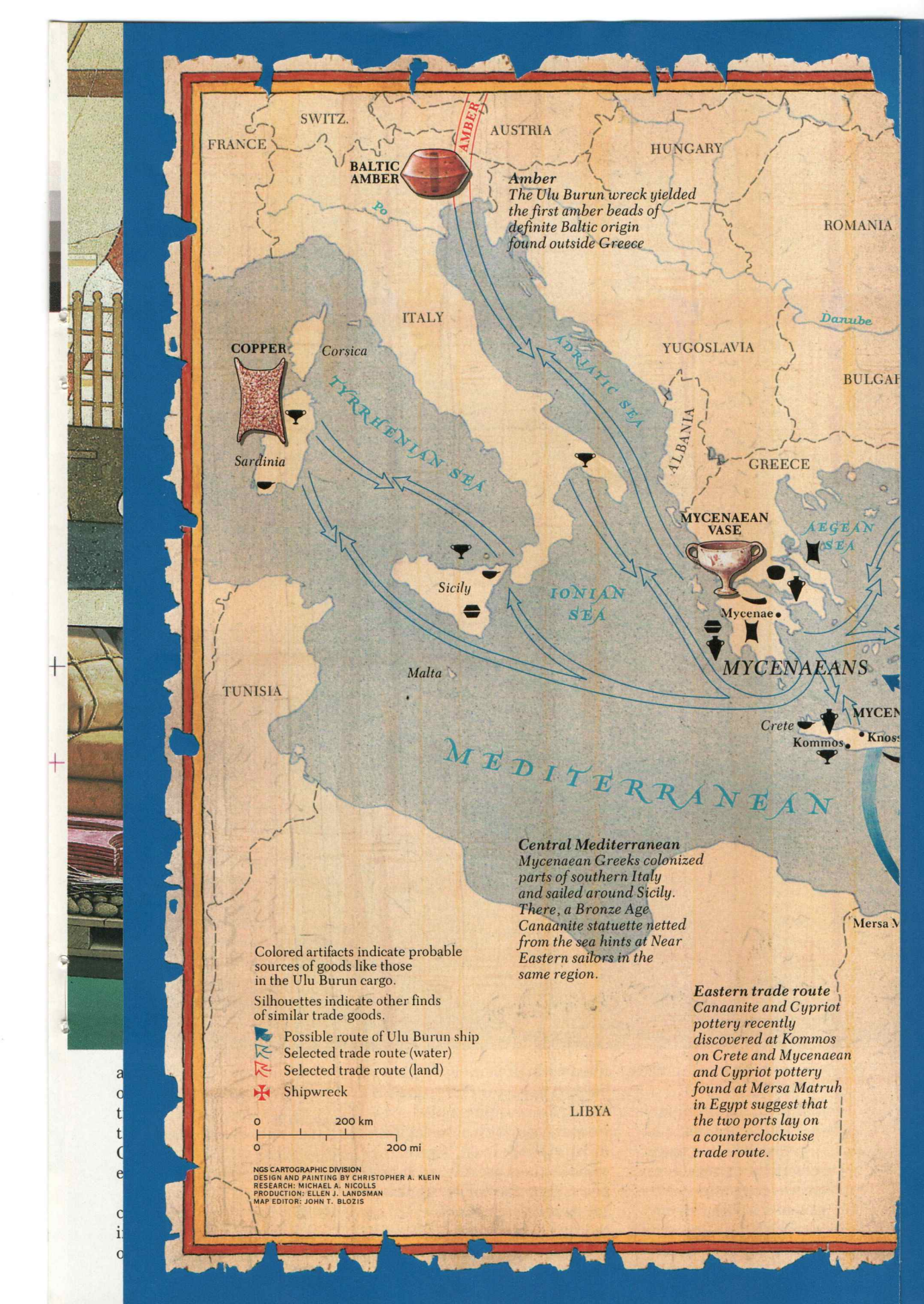


PAINTING BY NED AND ROSALIE SEIDLER

are fastened with mortise-and-tenon joints.

Valuables in the stern, far right, include bronze swords and arrowheads, stone mace heads, ostrich eggshells, ivory, and Mycenaean pottery. The hold at center stores fishing nets, blue glass ingots, logs of exotic wood, and amphorae filled with aromatic resin, flanked by storage jars. Copper and tin ingots are also stowed here, with more copper forward of the mast, where stone anchors are stacked in pairs. Atop the ballast stones the goods were cushioned by thorny burnet, a common Mediterranean shrub.

A RESEARCH PROJECT SUPPORTED IN PART BY YOUR SOCIETY


SWITZ.
FRANCE
AUSTRIA
HUNGARY
AMBER
BALTIC AMBER
Amber
The Ulu Burun wreck yielded the first amber beads of definite Baltic origin found outside Greece
Po
ROMANIA
Danube
ITALY
COPPER
Corsica
YUGOSLAVIA
ADRIATIC SEA
TYRRHENIAN SEA
ALBANIA
BULGAR
Sardinia
GREECE
MYCENAEAN VASE
AEGEAN SEA
Sicily
IONIAN SEA
Mycenae
MYCENAEANS
Malta
TUNISIA
MYCEN
Crete
Knoss
Kommos
MEDITERRANEAN
Central Mediterranean
Mycenaean Greeks colonized parts of southern Italy and sailed around Sicily. There, a Bronze Age Canaanite statuette netted from the sea hints at Near Eastern sailors in the same region.
Mersa M
Colored artifacts indicate probable sources of goods like those in the Ulu Burun cargo.
Silhouettes indicate other finds of similar trade goods.
Possible route of Ulu Burun ship
Selected trade route (water)
Selected trade route (land)
Shipwreck
Eastern trade route
Canaanite and Cypriot pottery recently discovered at Kommos on Crete and Mycenaean and Cypriot pottery found at Mersa Matruh in Egypt suggest that the two ports lay on a counterclockwise trade route.
LIBYA
0 200 km
0 200 mi
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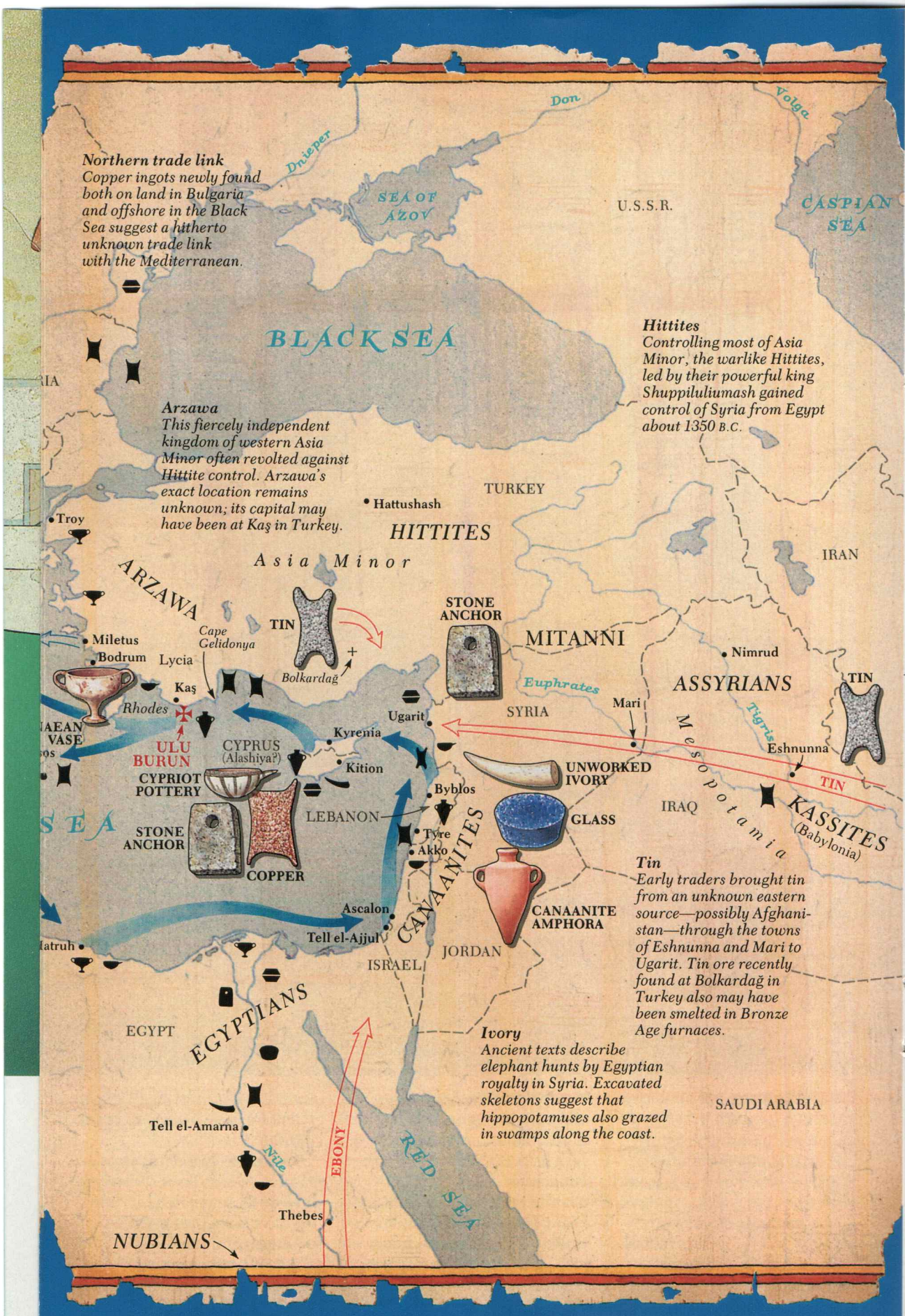

Northern trade link
Copper ingots newly found both on land in Bulgaria and offshore in the Black Sea suggest a hitherto unknown trade link with the Mediterranean.
Don
Volga
Dnieper
SEA OF AZOV
U.S.S.R.
CASPIAN SEA
BLACK SEA
Hittites
Controlling most of Asia Minor, the warlike Hittites, led by their powerful king Shuppiluliumash gained control of Syria from Egypt about 1350 B.C.
Arzawa
This fiercely independent kingdom of western Asia Minor often revolted against Hittite control. Arzawa's exact location remains unknown; its capital may have been at Kaş in Turkey.
TURKEY
Hattushash
HITTITES
Asia Minor
Troy
ARZAWA
IRAN
TIN
STONE ANCHOR
Bolkardağ
MITANNI
Miletus
Bodrum
Lycia
Cape Gelidonya
Nimrud
Euphrates
ASSYRIANS
TIN
Kaş
Rhodes
Ugarit
SYRIA
Mari
Tigris
Mesopotamia
AEAN VASE
ULU BURUN
CYPRUS (Alashiya?)
Kyrenia
Eshnunna
TIN
CYPRIOT POTTERY
Kition
UNWORKED IVORY
Byblos
IRAQ
KASSITES (Babylonia)
SEA
LEBANON
GLASS
STONE ANCHOR
Tyre
Akko
COPPER
CANAANITES
Tin
Early traders brought tin from an unknown eastern source—possibly Afghanistan—through the towns of Eshnunna and Mari to Ugarit. Tin ore recently found at Bolkardağ in Turkey also may have been smelted in Bronze Age furnaces.
Ascalon
CANAANITE AMPHORA
Tell el-Ajjul
JORDAN
ISRAEL
EGYPTIANS
EGYPT
Ivory
Ancient texts describe elephant hunts by Egyptian royalty in Syria. Excavated skeletons suggest that hippopotamuses also grazed in swamps along the coast.
SAUDI ARABIA
Tell el-Amarna
Nile
EBONY
RED SEA
Thebes
NUBIANS

BRONZE AGE TRADE

By the time the Ulu Burun ship sank in the 14th century B.C., a vast trade network was well established among various racial and linguistic groups centered on the Mediterranean, from subtropical Africa and the Near East to northern Europe. The loss represented by the wreck is revealed in the great distances the cargo was transported by land and sea before being loaded aboard for the voyage.

Ore for the ship's copper ingots almost certainly was mined on the island of Cyprus, believed to be ancient Alashiya. Yet the distinctive shape of the ingots, with four "legs," or handles, may represent Near Eastern influence: The only known casting mold for such shapes was excavated at a ruined palace near the ancient city of Ugarit on the Syrian coast.

Similar ingots have been found as far west as the island of Sardinia. While I believe those ingots were cast from local ore, their shape may suggest a Near Eastern presence in the western Mediterranean in the Late Bronze Age.

The same type of ingots arrived in Egypt in great numbers, as evidenced by Egyptian tomb paintings that show them stacked in royal storerooms or borne by Syrian porters bringing tribute.

Suggested sources of Bronze Age tin range from Cornwall in England to as far east as China and Thailand, though I believe neither area supplied the tin we have found on the Ulu Burun wreck. Clay tablets dating four centuries earlier mention tin being brought westward overland through the Near Eastern city of Eshnunna to the Syrian coast for shipment. Our tin may have come from Afghanistan or perhaps from Turkey, where fieldwork by Aslihan Yener, supported by the National Geographic Society, recently located another source.

The design of many jars on the wreck was obviously Canaanite, a term applied to the Bronze Age culture that flourished along the extreme eastern Mediterranean coast.

More exotic trade goods included ebony-like wood, which grew in Africa to the south of Egypt. Other finds included amber, which has since been identified as a type found in northern Europe, known as Baltic amber. There was also ivory in the form of elephant and hippopotamus tusks, both probably originating along the Syro-Palestinian coast, and ostrich eggshells.

Certainly goods of all types were widely distributed during the Bronze Age. The distinctive pottery of the Mycenaeans, or Bronze Age Greeks, is found in every country from Cyprus to the Nile Valley and from Syria to as far west as Sardinia. Canaanite amphorae have been found in both Greece and Egypt, and Cypriot pottery has been identified at Kommos in Crete and in various parts of Egypt.

It seems likely that Bronze Age ships such as the one at Ulu Burun plied the Mediterranean in a circular pattern, sailing from Syria-Palestine to Cyprus, to the Aegean and occasionally to Sardinia, then back by North Africa and Egypt.

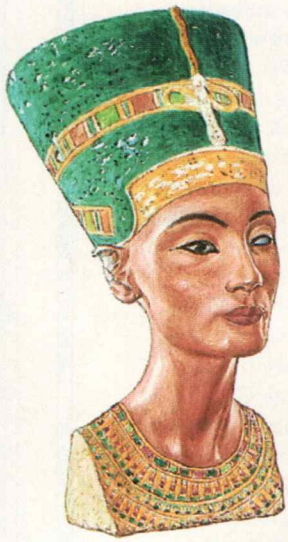
Bronze weapons and tools recovered from the Ulu Burun wreck represent a variety of designs, including Mycenaean, Canaanite, and Egyptian. Jewelry seems mostly Canaanite.

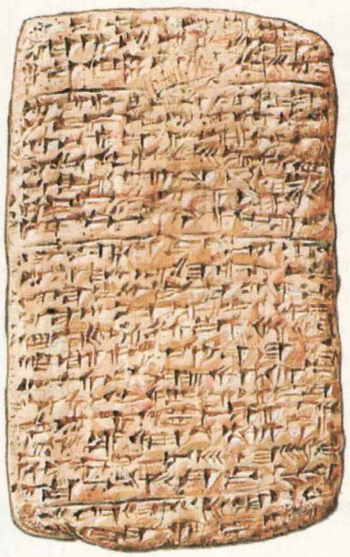
Mesopotamian cylinder seals such as the ones we found on the ship have been discovered in Cyprus and Greece and are known to have been sent as gifts to the Egyptian pharaohs.

Finally, stone anchors similar to the 16 so far uncovered on the Ulu Burun wreck have been found in Cyprus, Egypt, and Syria.

Thus the Ulu Burun wreck provides a detailed and colorful chart of trade routes and cargoes in the Mediterranean more than 3,000 years ago.

COSMOPOLITAN WORLD





BUST OF QUEEN NEFERTITI AND 377 CLAY TABLETS, INCLUDING THE ONE ABOVE, WERE FOUND AT TELL EL-AMARNA, EGYPT. ÄGYPTISCHES MUSEUM, WEST BERLIN (TOP), BRITISH MUSEUM. ARTIFACTS PAINTED BY CHRISTOPHER R. KLEIN.

THE DISCOVERY that copper and tin could be combined to form a new and stronger metal—bronze—dramatically changed the course of human history.

From around 3000 B.C., tools and weapons made of this remarkable alloy began to replace crude implements of stone, wood, bone, and copper. What had once taken a farmer days to cultivate could now be done in a matter of hours. With relative speed shipwrights using bronze tools could build hulls capable of carrying bulk cargoes vast distances with only the energy of the wind to drive them. Such advances allowed trade to expand throughout the eastern Mediterranean world.

The ship excavated at Ulu Burun sank during the heyday of the Late Bronze Age—from about 1600 B.C. until 1050 B.C., when iron began to replace bronze as the preferred metal.

The ship carried products of at least seven cultures—Mycenaean Greek, Canaanite, Cypriot, Egyptian, Kassite, Assyrian, and Nubian. These varied products emphasize the economic ties that existed among Bronze Age kingdoms too often studied today as separate geographic entities.

During the 14th century B.C., when the Ulu Burun ship most likely sailed, Bronze Age Greeks were constructing their great palace at Mycenae, from which their name is drawn—Mycenaeans. They set up trading outposts and colonized the islands and shores of the Aegean and Ionian Seas from Asia Minor to southern Italy. They were the forebears of the fabled Homeric heroes—Agamemnon, Achilles, and Odysseus—who sailed to Troy a century later.

In the 14th century, however, the Mycenaeans sailed more for trade than conquest. Their ceramics reached virtually every city in the eastern Mediterranean and areas as far west as Sardinia. But the nature of Mycenaean maritime trade is unknown. There are no depictions of Mycenaean ships or sailors in contemporary Egyptian art, and we have not yet found a word for "merchant" in the Mycenaean language. Perhaps Mycenaean goods were often carried in foreign vessels.

Although the Mycenaeans had colonies along the coast of western Asia Minor, they seem to have had little contact with their linguistic cousins, the Hittites, who controlled much of the interior. An inland people who lived in fortresses no less imposing than those of the Mycenaeans, the Hittites already knew the secret of iron.

Hittite kings vied with Egyptian pharaohs over the land inhabited by the Canaanites. The term Canaanite is generally used to denote peoples living during the second millennium B.C., on the Syro-Palestinian coast, a strip of land that

OF THE LATE BRONZE AGE

controlled trade routes connecting Egypt, Mesopotamia, and the Hittite Empire, and whose ports controlled trade with Cyprus, Crete, and lands beyond. Seafaring Canaanite ships are depicted in 14th-century Egyptian art.

Farther east, Babylonia was ruled by the Kassites, a people who have left so few records we know little about them.

The figure of an early 12th-century B.C. bronze warrior standing on a four-handled ingot (right) found on Cyprus perhaps represents a deity protecting the island's copper supply. But the figure, like Cyprus, is enigmatic. Scholars can read documents left by Egyptians, Hittites, Canaanites, and Mycenaeans, but they have deciphered only a few words of the Bronze Age Cypriot language. And though we know the appearance and clothing of Hittites, Canaanites, Egyptians, Mycenaeans, and Nubians, we lack detailed depictions of the Cypriots.

During the 14th century Egypt's foreign influence waned under Pharaoh Akhenaten, whose queen was the beauteous Nefertiti. At a site on the Nile known as Tell el-Amarna the famous bust of Nefertiti (opposite) was discovered, as were 377 priceless clay tablets inscribed in cuneiform that offer a portrait of Egypt's diplomatic relations in the Late Bronze Age. The tablet (opposite, below) was sent to a pharaoh, probably by the king of Cyprus, apologizing for the small size of a copper shipment.

In 1361 B.C., one year after Akhenaten's death, Tutankhamun took the throne at the age of eight or nine. He died ten years later and would be little remembered had not his opulent tomb been discovered in 1922.

The exact nature of international trade in the 14th century B.C. is not fully understood. Private enterprise is suggested by clay tablets that list prices of various commodities. Trade was also conducted as exchanges of "royal gifts."

Many of those exchanges are recorded on the clay tablets found at Tell el-Amarna. Although most are royal documents from Egyptian vassals in Syria and Palestine, they include correspondence to Egyptian kings from Cypriot, Hittite, Kassite, Assyrian, and other rulers.

This tightly knit world would soon unravel. Around 1200 B.C. civilization in Greece came to a violent end, at whose hands we do not know.

The Hittite Empire was overrun, again by unknown forces, followed by wholesale destruction on Cyprus and along the Syro-Palestinian coast. Only Egypt repelled the incursions.

We do not yet know the reason for this violent ending to the Bronze Age, but the Ulu Burun shipwreck provides a fascinating portrait of that great era before its death. * * *

BRONZE STATUE OF AN ARMED GOD, EARLY 12TH CENTURY B.C., CYPRUS MUSEUM, NICOSIA.

I FELT no emotion as I scanned the cargo for the first time that summer of 1984. I was standing upright, my diving fins resting on a rock outcrop 150 feet below the surface of the Mediterranean.

The world's oldest known shipwreck lay before me—the shapes of jars and copper ingots dated back to the 14th or early 13th century B.C. But I had no more than five minutes to plan its excavation.

Five minutes to estimate the lie of the ship's hull beneath its cover of sand and cargo. Five minutes to decide where to place our air-filled Plexiglas dome—dubbed the "phone booth"—in which our divers might take refuge in an emergency or telephone the surface. Five minutes to decide what mapping techniques we would use. Five minutes spent fighting nitrogen narcosis caused by breathing at such depth.

Thousands of dives over more than a quarter of a century had trained me to fight the dullness clouding my mind. But the effort left no room for fancy or romance. Quickly I drew up a mental plan of action and a list of priorities, then started for the surface.

Decreasing water pressure lifted the fog of narcosis as I swam upward to our research vessel, *Virazon,* moored just 50 yards from Ulu Burun, a rocky finger protruding from Turkey's southern coast into the Mediterranean (map, pages 697-98).

As I climbed aboard, I was met by my Turkish assistant, Cemal Pulak. "That's the most exciting dive I ever made," I said. Then I turned to two American colleagues, Don Frey and Jack Kelley, and added, "You two sure do find good wrecks."

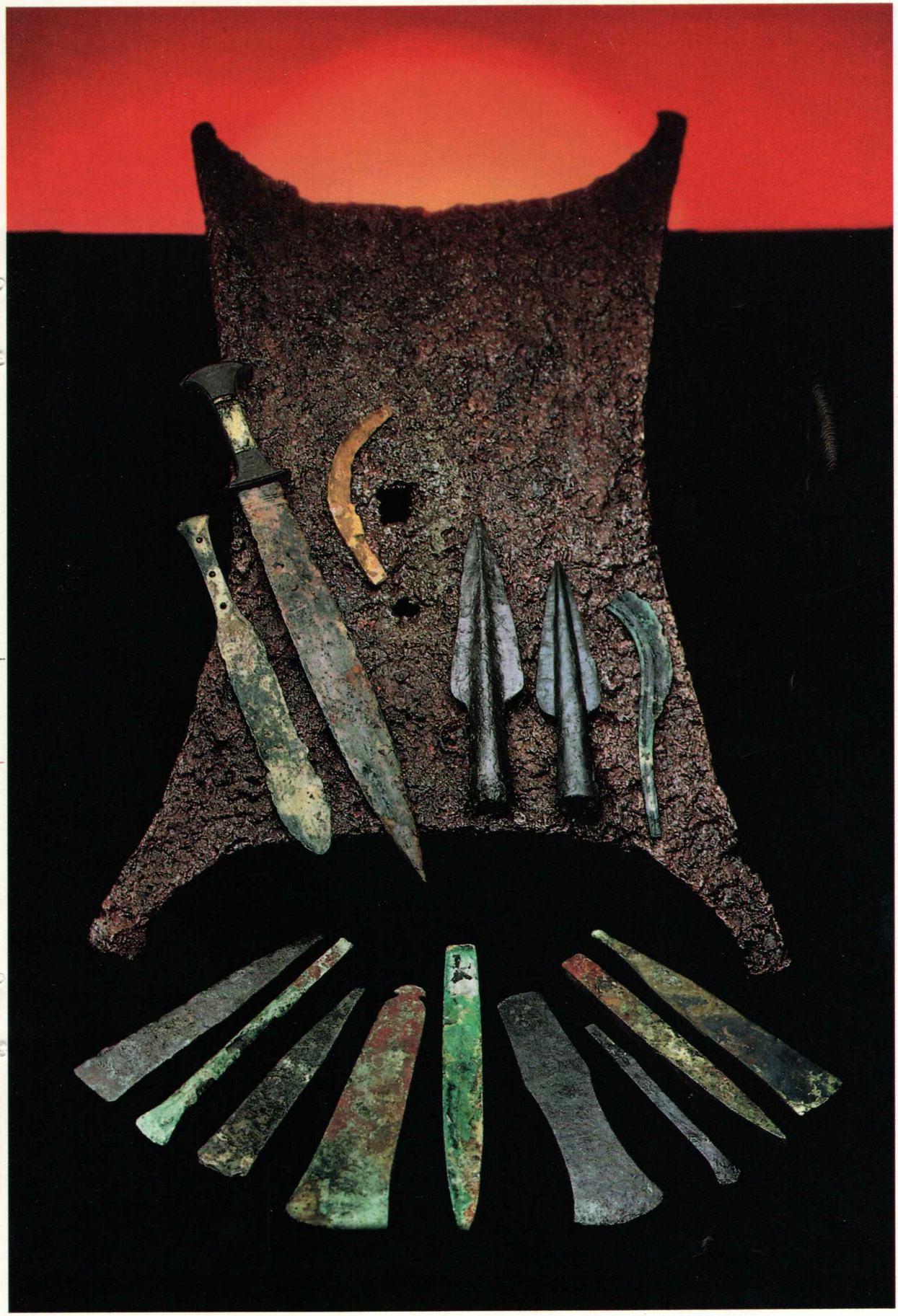
In a sense the wreck had been found for us rather than by us. For 27 years I have been excavating ancient shipwrecks along the coast of Turkey.* In 1973, to help support that work, I founded what we now call the Institute of Nautical Archaeology—INA, for short—at Texas A&M University in College Station. Don Frey is the president of INA, and Jack Kelley is one of its founding directors.

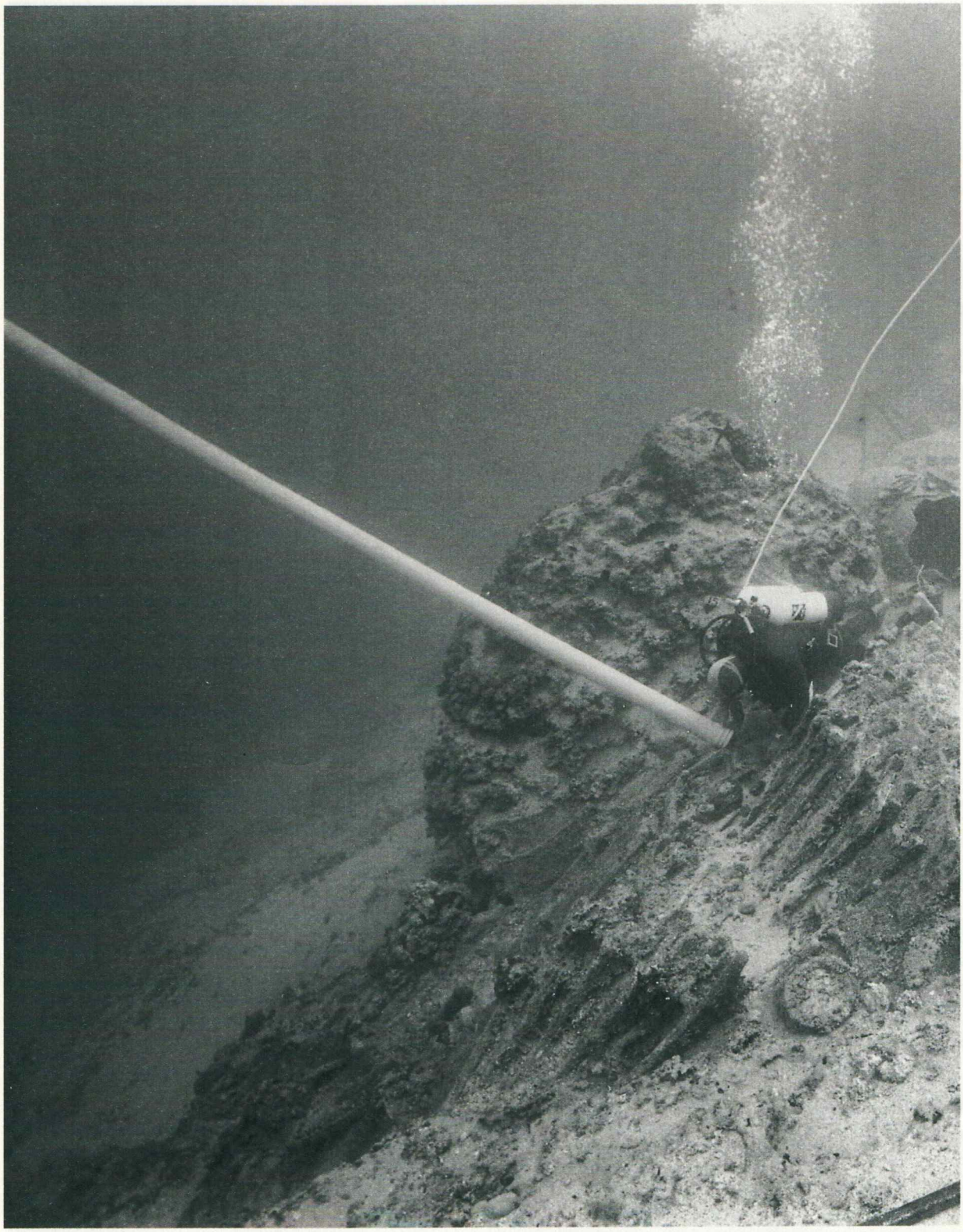
Long experience has taught us that the best sources of information about ancient shipwrecks are the divers on Turkey's sponge boats. For search purposes the divers are far more valuable than the most sophisticated sonar and magnetometers in existence. Cemal and Don recently calculated that in a single four-month summer season the *(Continued on page 708)*

EVER SO HUMBLE in appearance, tin artifacts were among the most exciting finds. A round bun ingot and one-quarter of a four-handled ingot (above, at top)—the earliest known—were mixed with copper to make bronze. A mug, pilgrim flask, and bent plate (at bottom) double the total of Bronze Age tin artifacts ever found.

In front of a 60-pound copper ingot (opposite), a bronze dagger, a sword, spearheads, and cutting tools such as chisels are a mix of Canaanite, Mycenaean, Cypriot, and Egyptian designs. The ship must have groaned under its six tons of copper—enough, alloyed with tin, to equip a small army.

*See "Glass Treasure From the Aegean," June 1978; "New Tools for Undersea Archeology," September 1968; and "Underwater Archeology: Key to History's Warehouse," July 1963, all by George F. Bass.





BARING THE BONES of the 14th century B.C., assistant excavation director Cemal Pulak, at left, uses an air lift to remove sediment from a long row of copper ingots. The vessel came to rest on a steep slope, one end about 170 feet deep, near the large rock outcrop. Nitrogen buildup at such depths

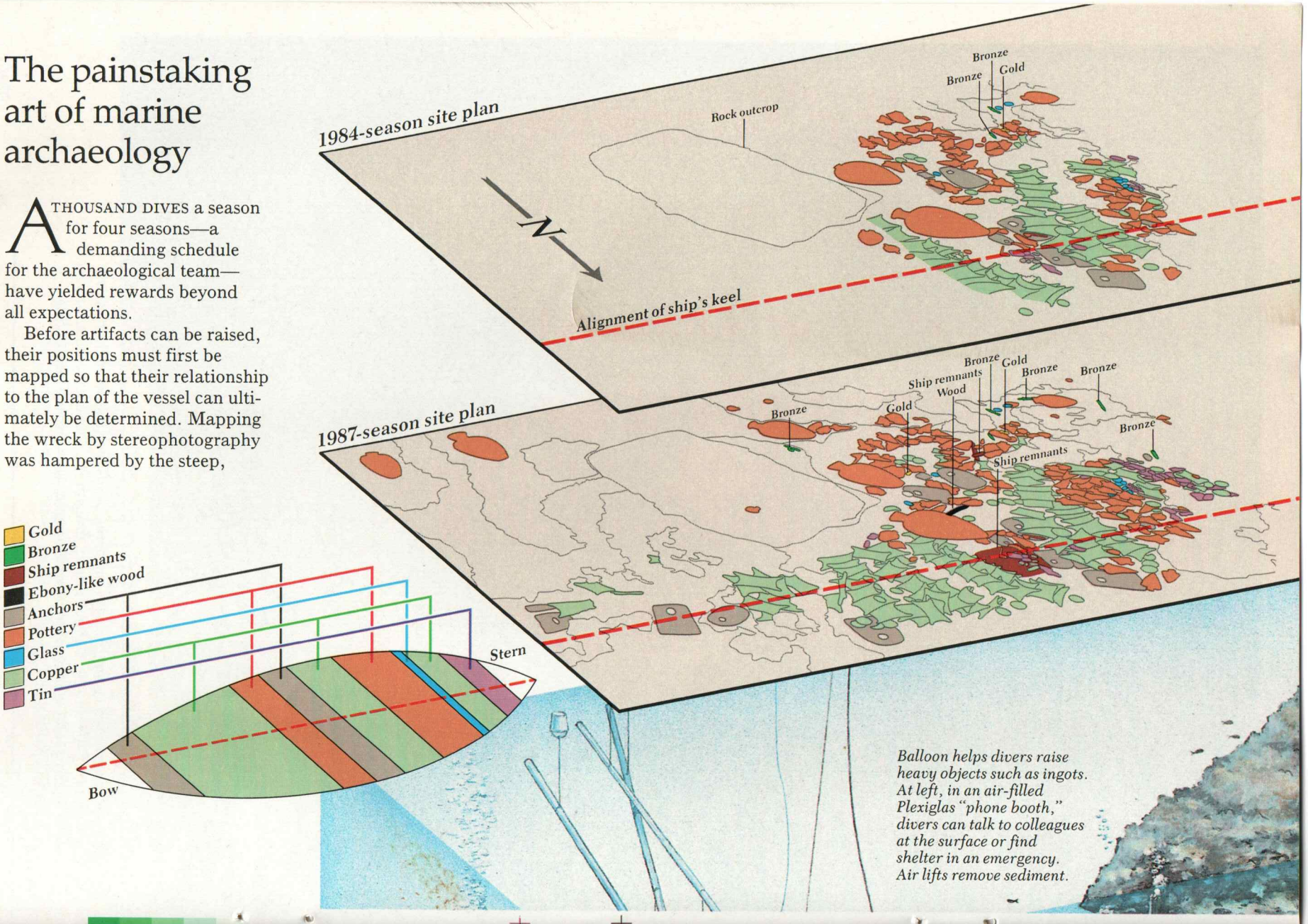
ROBIN PIERCY, INSTITUTE OF NAUTICAL ARCHAEOLOGY

not only fogs thinking but can also cause the bends, so dives were limited to a maximum of 20 minutes. Tufan Turanlı, foreground, vacuums sediment near stone anchors. Old anchors were used during the same period as building materials in Syria and Cyprus.

The painstaking art of marine archaeology

A THOUSAND DIVES a season for four seasons—a demanding schedule for the archaeological team—have yielded rewards beyond all expectations.

Before artifacts can be raised, their positions must first be mapped so that their relationship to the plan of the vessel can ultimately be determined. Mapping the wreck by stereophotography was hampered by the steep,



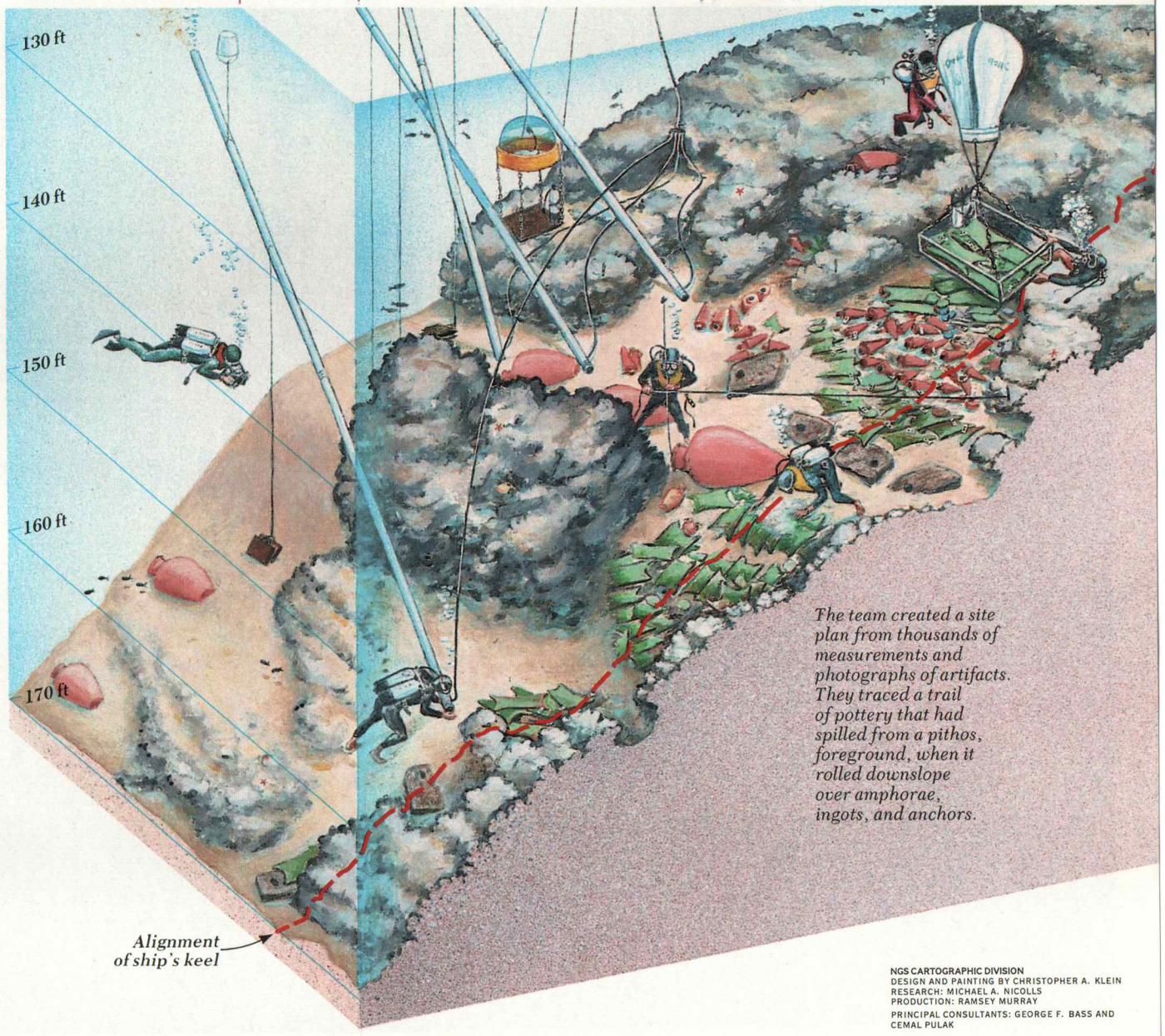
Balloon helps divers raise heavy objects such as ingots. At left, in an air-filled Plexiglas "phone booth," divers can talk to colleagues at the surface or find shelter in an emergency. Air lifts remove sediment.

uneven slope where she lies (bottom right). Nevertheless, precise results were achieved by triangulation with measuring tapes.

The dashed line locates the ship's keel. In nearby sandy areas excavation was relatively easy. The site's upper end proved to be a solid concretion of cargo, such as amphorae and ingots, that had to be meticulously chiseled free.

Site plans compare progress from the 1984 season with that of early 1987 (above right). Artifacts are color coded, and some are positioned relative to the ship's hull (key above). Many of those whose locations are shown have not yet been recovered. Excavation in 1984 concentrated on the shallower portion of the site and uncovered copper ingots, stone anchors, amphorae, and large storage jars. One sandy gully there yielded extraordinary treasures including raw ivory, jewelry of gold, silver, and amber, glass ingots, and a gold chalice.

Two years later the inventory had increased dramatically. Egyptian connections surfaced in the form of scarabs and ebony-like logs. And an accumulation of crushed or defaced jewelry suggests precious scrap metal.



The team created a site plan from thousands of measurements and photographs of artifacts. They traced a trail of pottery that had spilled from a pithos, foreground, when it rolled downslope over amphorae, ingots, and anchors.

NGS CARTOGRAPHIC DIVISION
DESIGN AND PAINTING BY CHRISTOPHER A. KLEIN
RESEARCH: MICHAEL A. NICOLLS
PRODUCTION: RAMSEY MURRAY
PRINCIPAL CONSULTANTS: GEORGE F. BASS AND CEMAL PULAK

(Continued from page 702)

divers on 25 boats spend a combined total of about 20,000 hours roaming the seabed in the quest for sponges. The figure works out to the equivalent of about two years' underwater search by one marine archaeologist—without coming up for air!

As a result we have come to know the sponge divers well, and during the winter Don and his Turkish colleagues give slide-show lectures in the divers' villages to teach them what to look for in the way of ancient wrecks. One of the most distinctive clues to a wreck is an exposed Bronze Age copper ingot. These ingots were frequently cast in a shape resembling an oxhide, with a "leg," or handle, at each of the four corners.

We found 34 such ingots in 1960 on a wreck off Turkey's Cape Gelidonya—the first underwater site I ever excavated.* The artifacts recovered at Cape Gelidonya dated from around 1200 B.C., but unfortunately we found few remains of the ship's hull. Here at Ulu Burun in 1984 we were soon to uncover whole sections of beautifully preserved hull as well as the archaeological treasures it had carried.

"Metal biscuits with ears. . . ."

—Turkish sponge diver, Mehmet Çakır

LUSTY SEAFARER may have hoisted this ram's head drinking cup called a rhyton, *recovered from sand near the rock outcrop. It was crafted of faience, powdered quartz fused by heat with an alkali. The maker's nationality remains a mystery. Although the cup resembles others from Cyprus and Syria, it does not match them exactly.*

The first hint of a wreck at Ulu Burun came in the summer of 1982. A young diver named Mehmet Çakır told his captain that he had seen strange "metal biscuits with ears" on the seabed while working at a depth of 150 feet off the point.

The captain recognized the description as that of a Bronze Age copper ingot from a drawing Don had circulated among the sponge boats. Çakır's discovery was reported to Turkey's Museum of Underwater Archaeology in the town of Bodrum, where INA has its Turkish base. Divers from the museum and from INA quickly visited the site. They confirmed the existence of a wreck and estimated its date as the 14th or 13th century B.C.

The following summer my assistant Cemal led a preliminary survey of the Ulu Burun site along with Don Frey and Jack Kelley. They returned to Texas in September with sketches and photographs to show me, and they were literally breathtaking.

Beginning at a depth of 140 feet and stretching another 30 feet down a steep slope lay a total of 84 copper ingots, many of them still in neat rows as they had been stowed nearly 34 centuries ago. Many more ingots lay partly obscured beneath the upper rows.

Other exposed items included six enormous storage jars, each as large as the ones that hid the thieves in *Ali Baba and the Forty Thieves*. There were also dozens of terra-cotta amphorae, obviously of Canaanite design.

*See "Oldest Known Shipwreck Yields Bronze Age Cargo," May 1962; and "Thirty-three Centuries Under the Sea," May 1960, by Peter Throckmorton.

Scattered among the larger containers were several small two-handled jars known today as pilgrim flasks, because their shape made them convenient to carry on long journeys.

Examining all the sketches and photographs, I could only agree with Don Frey: "We're looking at an archaeologist's dream."

In the end that proved an understatement, for Ulu Burun held undreamed-of treasures. The next summer, 1984, we mounted a full-scale expedition to map and excavate the site. That was when I had my first exciting view of the wreck.

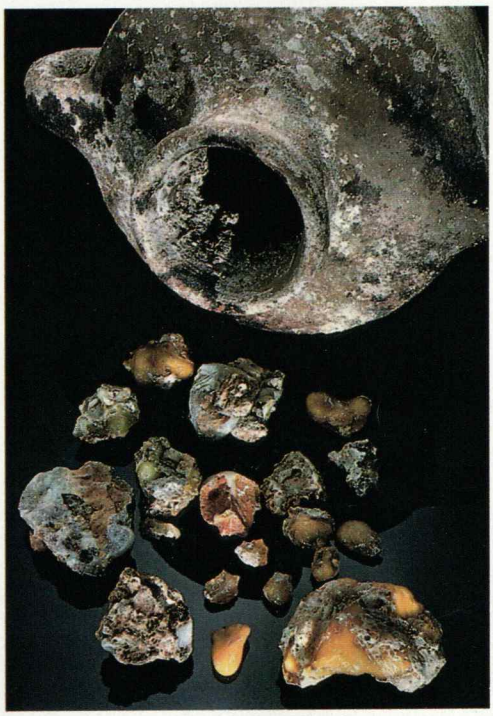
"I will bring to thee as a present two hundred talents of copper."

—Letter in the form of a clay tablet from the king of Alashiya to an Egyptian pharaoh, found at Tell el-Amarna, Egypt

As we carefully surveyed the site, we found that the ship's principal cargo had been copper ingots. There were about 200 of them—more than six times the number we had found at Cape Gelidonya. Each of the ingots weighs around 60 pounds, the equivalent of an ancient talent.

Months later I ran across a passage in one of the tablets from Tell el-Amarna mentioning a promised gift of 200 talents of copper from the king of Alashiya to an Egyptian pharaoh. The coincidence was stunning, and I could only speculate: Was the promised shipment ever sent from Alashiya, which we believe to be Cyprus? Did it reach Egypt? Or is it possible that the gift ended up on the seafloor off the point known today as Ulu Burun?

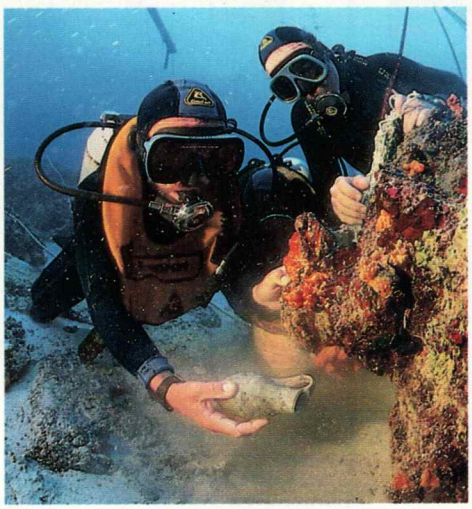
The chances that we had found that very cargo seemed remote, though I was soon convinced that the Ulu Burun ship nonetheless carried a royal consignment of some sort dating from the 14th century B.C.—in the Late Bronze Age, a period roughly between 1600 and 1050 B.C.



LUMP SUM of yellow terebinth resin might have fetched a fortune, the author believes. More than a hundred Canaanite amphorae were recovered, and most contained chunks of this resin. It has been found in Egyptian graves, but its purpose remains unknown. Its abundance among the cargo is second only to copper, suggesting the loss of another valuable consignment.

SUPPORT for our 1984 expedition came from INA and the National Geographic Society, later joined by the National Science Foundation, the Institute for Aegean Prehistory, and the National Endowment for the Humanities. I had assembled a crack team of excavators. Most had worked with me a decade or more on various wrecks along the Turkish coast. They included Aşkın Canbazoğlu and Yaşar Yıldız of the Bodrum museum staff, INA's Don Frey, Cemal Pulak, and Jack Kelley, along with Tufan Turanlı, Robin Piercy, and Murat Tilev, and archaeologists Faith Hentschel, Feyyaz Subay, and Lisa Shuey. Archaeobotanist Cheryl Haldane took on the job of identifying any plant remains we discovered.

As we had done in past years, we built a base camp ashore and moored *Virazon* directly over the wreck. Because of the dangerous depth—140 to 170 feet—we limited our initial time on the

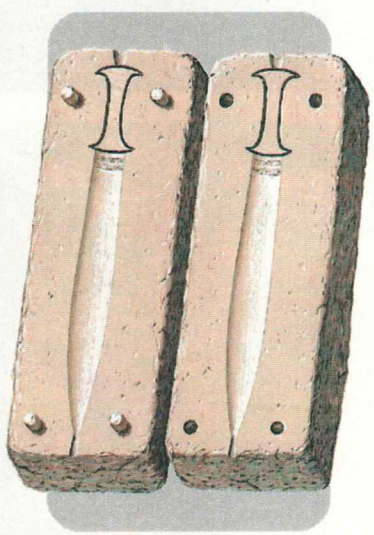


CHINA BARREL: *As divers began to raise one pithos, they were amazed when pottery poured from its mouth. The author (opposite, above) and Aşkın Canbazoğlu of Turkey's Bodrum Museum of Underwater Archaeology inspect the storage jar. From it Canbazoğlu removes a juglet, one of 18 pieces of Cypriot pottery still packed inside. Except for the Cypriot pitcher at upper left, which was found nearby, all the pottery shown above came from the pithos, including two juglets, oil lamps with pinched nozzles to hold wicks, wishbone-handled bowls of different types, and a small bucchero jug. The pottery's rough-hewn, rustic style may have made it popular export ware, especially to Syria and its neighbors.*

Casting a Bronze Age sword

SEAMAN'S SIDE ARM, an 18-inch-long bronze sword, excellently preserved by a mantle of encrustation, is examined by Faith Hentschel (left). A nearly identical short sword has been found at Akko, a Canaanite city on the Mediterranean. The sequence below, left to right, illustrates how such weapons were probably cast in one piece.

First a two-part stone mold was shaped, including two decorative bands for the base of the blade. Molten bronze was then poured into the mold. To the hardened sword's hilt were added inlays of wood, a long central ivory piece, and small adjacent bands of wood and ivory. The finished sword is also in the arms display on page 703.



wreck to only five minutes a dive. We gradually increased the time to 20 minutes twice a day, though it required long periods of subsequent decompression on pure oxygen.

ALMOST AT ONCE the wreck fulfilled our expectations. The first dives yielded disk-shaped copper ingots as well as the familiar four-handled style, a mace head of stone, a Canaanite amphora full of glass beads, and a second amphora filled with orpiment, a yellow sulfide of arsenic once used as pigment.

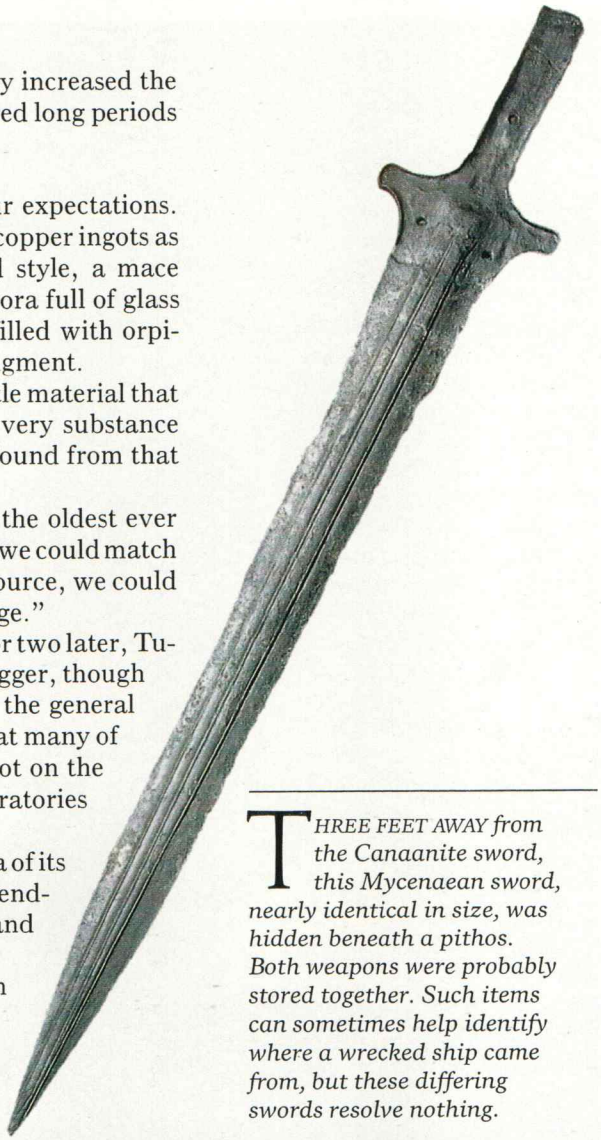
We also brought up samples of a grayish, brittle material that later proved to be 99.5 percent pure tin—the very substance that spurred on the Bronze Age but is seldom found from that period in raw form.

"If these are remnants of tin ingots, they're the oldest ever found," I told the staff over dinner one night. "If we could match such ingots chemically with tin from a known source, we could solve one of the great mysteries of the Bronze Age."

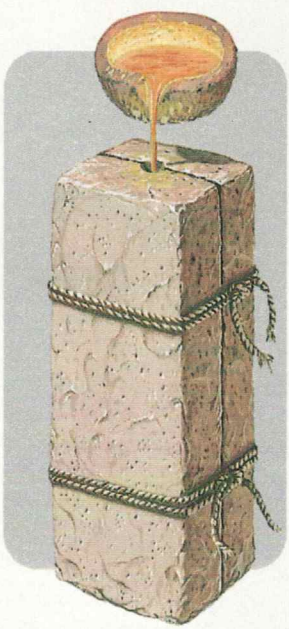
Soon afterward we did find tin ingots. A day or two later, Tufan brought up what appeared to be a bronze dagger, though the concretion surrounding it disguised all but the general shape. The story of the dagger demonstrates that many of our most exciting discoveries often are made not on the seafloor but in libraries, museums, and laboratories long after our expeditions end.

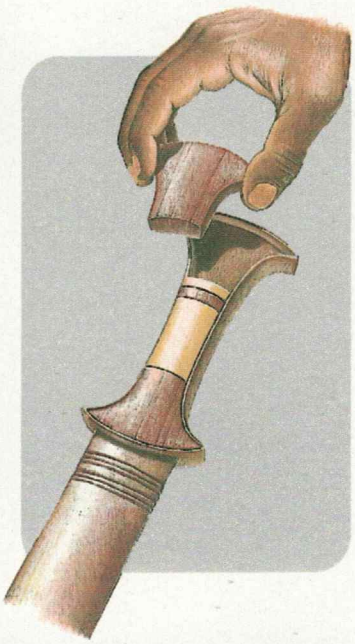
The dagger was so encrusted that I had no idea of its date or origin. We stored it wet until the season ended, and then conservator Jane Pannell cleaned and preserved it at our laboratory in Bodrum.

Under Turkish law all our finds must remain in Turkey, so INA staff illustrator Netia Piercy made a precise drawing of the dagger, whose exact shape and inscribed decoration were now



THREE FEET AWAY from the Canaanite sword, this Mycenaean sword, nearly identical in size, was hidden beneath a pithos. Both weapons were probably stored together. Such items can sometimes help identify where a wrecked ship came from, but these differing swords resolve nothing.





DONALD FREY (OPPOSITE); DRAWING BY T. W. RUTLEDGE

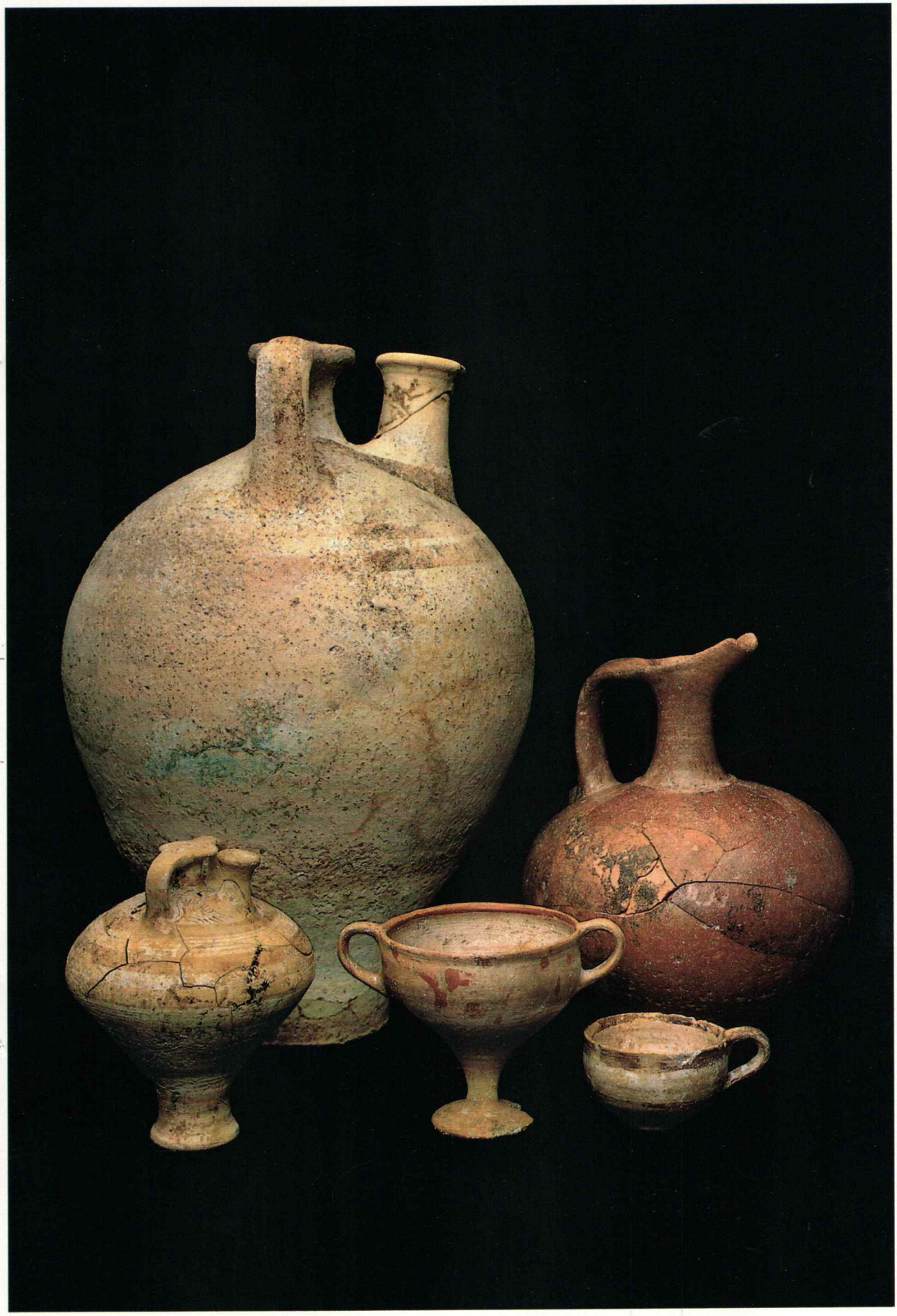
A cup fit for a king–but whose?

"THE INSURERS took a pounding when this ship sank, I'll tell you that!" joked Robin Piercy, an INA archaeologist, as he climbed aboard the research vessel Virazon with electrifying news: He had discovered a gold chalice.

Piercy discovered the treasure on the wreck's western edge, an area believed to be nearly barren. The chalice, made of two cones fastened by three rivets, with a thin strip as a collar to hide the junction, came to light among a cross-cultural group of artifacts (below). Surrounding the chalice, gleaming at center, lie a Canaanite amphora, at left, a Canaanite pilgrim flask, above—so called by archaeologists because it was suitable for a journey—and a two-handled Mycenaean cup called a kylix.

The juxtaposition ironically illustrates an archaeological scale of values. Although many authorities have now studied the precious gold chalice, nothing is yet known of its place of origin or date. However, the unpretentious terra-cotta kylix is of a style popular in the early 14th century B.C., and it thus serves as a relatively accurate dating tool, although the artifact could already have been several decades old when the ship went down.

The kylix, which may have been made on the Greek island of Rhodes, stands front and center in a collection of the wreck's Mycenaean pottery (right) that also includes a cup, a jug dated by its shape and faded decoration to the time of Pharaoh Akhenaten or earlier, and a pair of vessels, at left, called stirrup jars. All save the large stirrup jar, which may have stored oil, were probably tableware, suggesting that perhaps some of the crew were Greeks.



clear, and Don Frey photographed it from different angles.

The following winter, back in Texas, I was reviewing hundreds of archaeological reports when I turned a page and suddenly there was a photograph of our dagger. It was not the same dagger, of course, but one identical to ours. It had been excavated along with several others just like it at Tell el-Ajjul, the site of a Canaanite city in southern Palestine. I learned that the Canaanites had adapted the shape from earlier Egyptian daggers. The information offered strong evidence that our own dagger was probably Canaanite and dated from the Late Bronze Age.

If one multiplies the story of the dagger by 1,224—the number of artifacts we have so far raised and cataloged from the wreck at Ulu Burun—one begins to understand what underwater archaeology is really all about. On the average we devote two years to conservation and research for every month of diving on site. In short, nautical archaeologists spend comparatively little time in wet suits!

". . . tribute to [Tutankhamun] offered by Syria."

—Inscription beneath a painting in the tomb of Huy, Egyptian viceroy of Nubia, showing a Syrian bearing a four-handled copper ingot

The great number of copper ingots at Ulu Burun could support a theory I had held for more than a quarter of a century: that the Canaanites, or Bronze Age Phoenicians, played a major role in the maritime commerce of the eastern Mediterranean.

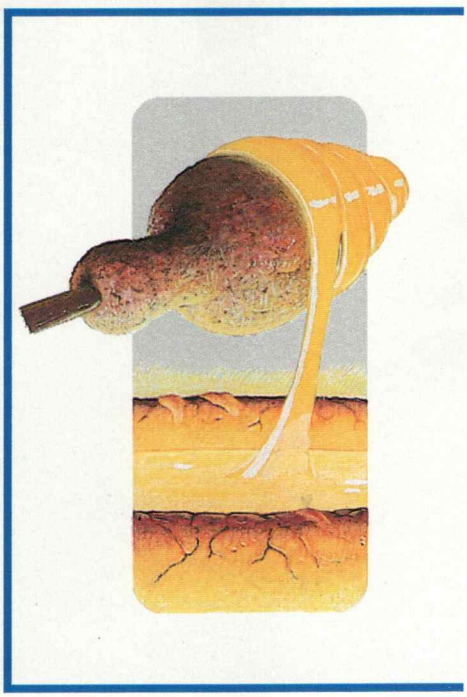
Many scholars insist that the Mycenaeans held a virtual monopoly on seaborne commerce during the Bronze Age. As proof they point to the widespread distribution of Mycenaean pottery throughout the Mediterranean. Where, they ask, is the evidence of Canaanite trade in the Mediterranean or the Aegean?

My answer is simple: On land, at least, that evidence quickly

Glass glitters in the cargo

"MEKKU-STONE" mentioned in Bronze Age letters of trade was almost certainly another of the wreck's commodities—blue glass ingots. Colored by cobalt, the six-inch-wide ingots are shown inverted. Chemical analysis reveals them to be identical to Egyptian and Mycenaean glass of the same era. Did one blue-glass maker have a monopoly?

His products could have been used in one of several glassmaking techniques (below right). First, molten glass was wound onto a core of clay and animal dung inside a furnace. Glass of a second color was then wound over the first. When reheated, the surface layer was worked to create a design. After the handles, rim, and foot were added, the core was broken up and removed from the vessel's mouth.



vanished. Mycenaean pottery tells only half the story. It wasn't given away; *something* had to have been traded in return. That something, I felt sure, came back to Greece from the Near East—something that has so far eluded archaeologists on land.

I have long believed that that something was Bronze Age raw materials such as copper, tin, ivory, glass, and other substances that were quickly converted on arrival into tools, weapons, ornaments, and household goods. Egyptian tomb paintings depict such raw materials in the hands of Canaanite merchants delivering them to the pharaohs, but the commodities themselves are seldom if ever found. Only a disaster such as a shipwreck would preserve them in their original form.

We had found such raw materials—the copper ingots, for example—at Cape Gelidonya in 1960. Careful study convinced me later that the ship had been Canaanite. I had dreamed that one day someone would discover a wreck with even richer evidence. Perhaps at last that day had come.

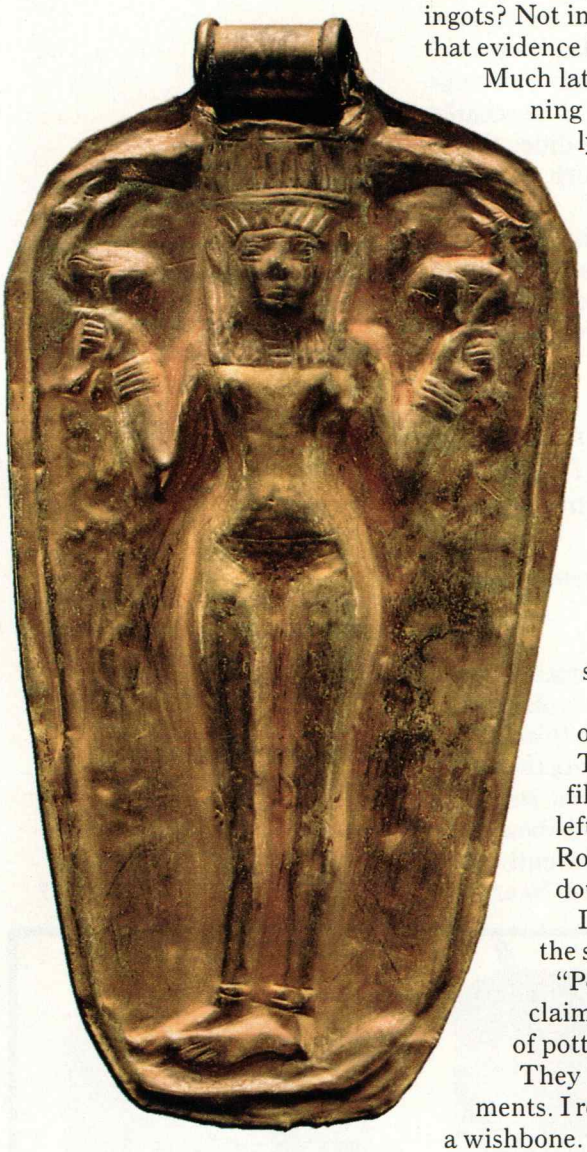
"The king, my lord, has written to me about the mekku-stone that is in my possession, but I have already given one weighing one hundred [units] to the king, my lord. . . ."

—Clay tablet from Prince Abi-milki of Tyre to Egyptian Pharaoh Akhenaten, found at Tell el-Amarna

Even from underwater we recognized the importance of our next discovery—a pair of opaque, cobalt blue glass disks, each six inches in diameter and two and a half inches thick. They were slightly rounded on their bottom edges. During the weeks that followed, we were to find many more such disks, some still stowed as neatly as they had originally been loaded aboard.

The secrets of the Bronze Age glass trade apparently were well kept. The late Leo Oppenheim, a renowned Near East

DRAWINGS BY T. W. RUTLEDGE, BASED ON RESEARCH BY ROBERT H. BRILL. CORNING MUSEUM OF GLASS, CORNING, NEW YORK



scholar, suggested in 1972 that what are called *mekku* and *ehli-pakku* in the Tell el-Amarna tablets were actually ingots of glass sent from Tyre and Ascalon to Egypt during the 14th century B.C. But Oppenheim's translation of the two words was not universally accepted. Where was the physical evidence of such ingots? Not in Egypt, Greece, or the Near East. Now we held that evidence in our hands—160 feet beneath the sea.

Much later Robert H. Brill, research scientist at the Corning Museum of Glass in Corning, New York, analyzed one of our glass ingots. He found it identical in content to blue glass in Egyptian bottles and Mycenaean medallions dating from the same period as the shipwreck.

Did Canaanite glassmakers—keeping their formula secret—ship ingots of this marvelous and mysterious substance to all parts of the eastern Mediterranean? Once more the wreck at Ulu Burun demonstrated what faint traces, if any, raw materials leave on land.

WE TURNED our attention next to the huge storage jars, known as *pithoi,* that Cemal had seen during his 1983 survey. "Let's bring up one of them so we can excavate underneath," I suggested at one of our regular staff meetings.

Tufan and Murat, both skilled at rigging heavy objects, wrestled a net under the jar I had chosen. They attached the net to a large balloon, partly filled the balloon with air to provide buoyancy, and left the jar on its side ready for lifting. Cemal and Robin, who were scheduled for the next dive, went down to raise it.

I thought someone was in trouble when they broke the surface later with surprise on their faces.

"Pottery's pouring out of the pithos!" Cemal exclaimed, and Robin chimed in: "The whole thing's full of pottery—look at these."

They handed up a basket full of intact pots and fragments. I removed a shallow bowl with a handle shaped like a wishbone. The piece was unmistakably Cypriot.

Unlike pottery produced elsewhere in the eastern Mediterranean during the Late Bronze Age, most Cypriot pottery was not wheel-made. It was therefore not quite symmetrical. Its rustic charm may have led to its popularity as an import to the Near East, where it has been found in such quantity that archaeologists originally thought it was made there. Recent neutron analysis of the clay, however, proves all of it was made on Cyprus.

Standing on *Virazon*'s deck with the bowl in my hand, I remarked to nobody in particular, "One thing I can say—this ship definitely was coming from Cyprus."

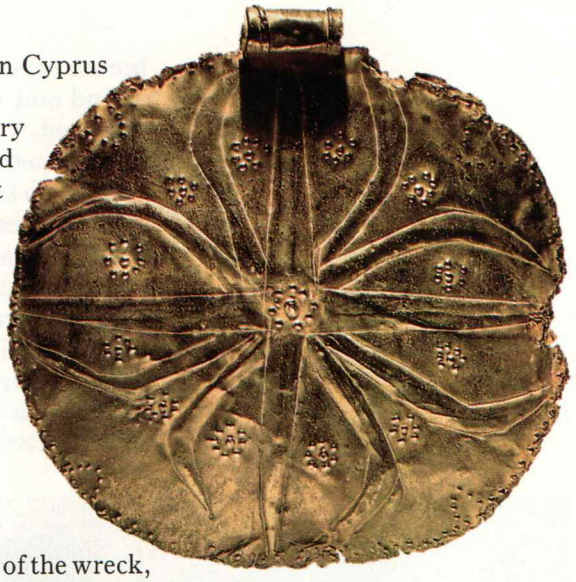
I quickly dived with Aşkın and Yaşar to look at the pithos, and we removed more pottery from inside it. In the end we

found nearly every major type of pottery made on Cyprus during the Late Bronze Age.

Equally surprising, however, was that the pottery was shipped in a pithos. Such large, open-mouthed jars appear on the decks of Canaanite merchant ships in a 14th-century Egyptian tomb painting. If asked their purpose, I would have guessed they were for fresh water. Now we know better: This pithos, at least, was used like a modern-day china barrel.

". . . this ship [is] the king's."

—Tablet from Tell el-Amarna from the minister of Alashiya to the minister of Egypt



Normally I assigned each diver to a specific area of the wreck, so that he or she would become familiar with it. I had kept our expedition doctor, Karl Ruppert, on the seemingly barren western edge of the wreck, thinking that as a newcomer he could do no harm while gaining experience.

After several weeks Karl had to return to his practice in the States, and an old hand, Yancey Mebane, took over as expedition doctor. To my sorrow, Karl never had the thrill of making a major discovery in his area, but he had come close. On his departure I asked Robin Piercy to explore his sector.

Within an hour Robin made the first in a series of spectacular finds that were to come from this area. As Robin fanned away sand from the bottom, something caught his eye that sent him heading for our underwater phone booth. Once inside he removed his mouthpiece and telephoned *Virazon,* 150 feet above him. Don Frey answered.

"Get George from shore to the ship," Robin said. "I've got something really interesting. I'm leaving it in place, and I'm coming up."

I reached *Virazon* just as Robin surfaced, and we all leaned over the rail to hear his news.

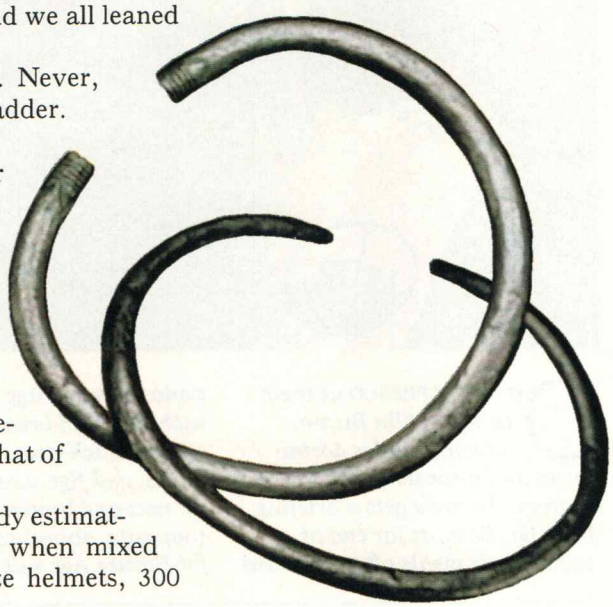
"I've never seen gold like that underwater. Never, ever," he said, pausing halfway up the diving ladder. "It's a large cup, I'm sure of it."

We were jubilant. In itself gold is of no greater value than lead or wood to the archaeologist, but this discovery was a further indication that we were on to something far more important than the Cape Gelidonya wreck we had excavated in 1960. That ship had carried 34 four-handled copper ingots and some scrap bronze weighing in all no more than a ton. At the time I had concluded that the vessel represented a modest commercial venture, perhaps that of an itinerant seagoing smith.

But here at the Ulu Burun site we were already estimating that we had six tons of copper—enough when mixed with tin to manufacture a total of 300 bronze helmets, 300

PRECIOUS METAL FINDS accumulated steadily, including both intriguing artifacts and scrap destined to be melted down. A gold pendant bears a nude goddess grasping a gazelle in each hand (facing page). Her identity is unknown, but a similar pendant has been found in Syria.

A gold medallion (above), three inches in diameter and adorned with a Canaanite star design, resembles others known to have been worn by Syrian merchants and sailors. A pair of silver bracelets (below) are probably also Canaanite.



bronze corselets, 3,000 spearheads, and 3,000 bronze swords!

And now the gold cup. Although not quite proof of a royal shipment, it strengthened my belief that the ship had been carrying something of the sort. I summed up my feelings to Robin: "This is no tramp steamer we're dealing with."

As we cleared away more sand, we found that the cup was shaped like a chalice, formed of two gold cones riveted together at their apexes. Almost touching the chalice was a common Mycenaean terra-cotta stemmed cup known as a *kylix,* which has since proved of greater historical value than the chalice. The date and origin of the chalice remain unknown, but the humble kylix is of a distinctive shape in vogue only at the end of, and shortly after, the reign of Egyptian Pharaoh Amenhotep III,

DINING ALFRESCO at their camp on Ulu Burun, which includes dormitories and a conservation laboratory, the crew gets a briefing from Dr. Bass, at far end of table. Their meals often included typical Bronze Age fare (right), such as round bread loaves, cheese, chick-peas, garlic, goat, olives, and figs. Lead weights for nets and bronze hooks (opposite, above) caught supper for Bronze Age sailors.

who ruled from 1417 to 1379 B.C. So our ship probably sank during the early 14th century, or shortly after, for we have no way of estimating how old the kylix was when it was lost.

"Now, as a present for thee . . . one elephant's tusk . . . I have sent."

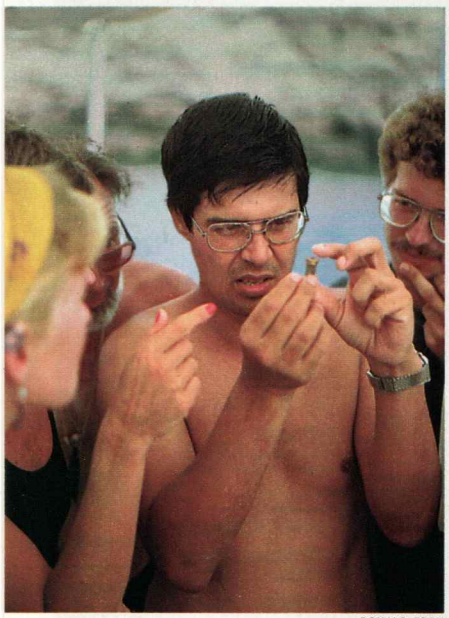
—Tablet from the minister of Alashiya to the minister of Egypt, found at Tell el-Amarna

I assigned the area of the chalice permanently to Cemal, because of his uncanny ability to understand exactly what he sees underwater. On one of my dives to the chalice I had noticed a

pointed object—a stick of wood, I thought—protruding from the sand nearby. After a single glance at the object Cemal surfaced and announced happily: "We have a hippopotamus tooth on the wreck!" Once again he was correct.

From the area of the hippopotamus tooth we brought up an eight-inch length of elephant tusk neatly sawed at both ends, possibly to fashion a cosmetic box (pages 726-7). Now we could add ivory to copper, tin, and glass as raw materials in our cargo.

Near the elephant tusk we uncovered several silver bracelets that I later identified as probably Canaanite, followed by a gold pendant shaped like a falcon clutching baglike objects in its talons. Months later when I saw the same design on a pair of Canaanite earrings from a museum in the Netherlands, I realized that the "bags" were hooded cobras.



DONALD FREY

INDELIBLE SIGNATURE, a quartz cylinder seal is examined by Cemal Pulak (above). To close a deal, traders rolled such seals on a clay tablet, leaving an impression of their personal motif.

This one depicts three figures, probably gods, approaching a fourth, perhaps a king. The seal (facing page), with its gold caps, may have been worn as jewelry. Dominique Collon, a specialist in seals, dates the artifact to about 1350 B.C. It is similar to seals used by the Kassites, rulers of Babylonia during that era.

THE RAW MATERIALS on board the Ulu Burun ship, together with the Cypriot pottery and Canaanite amphorae, weapons, and jewelry, all had eastern Mediterranean connections, establishing that our ship was sailing from east to west when it sank.

But the discovery of several carved amber beads presented a problem. Amber, or fossil resin, occurs naturally in Sicily and other areas of the Mediterranean, but the Ulu Burun beads were later identified by Curt Beck of Vassar College as Baltic amber, which occurs in an arc sweeping across northern Europe from the Baltic south to the Black Sea. Our beads, which were carved in typical Mycenaean shapes, seemed to be moving in the wrong direction for the ship's cargo—that is, from west to east instead of east to west. Were they simply worn by a Mycenaean Greek merchant making a return voyage from some port in the Near East? The discovery nearby of a stone seal carved with a Mycenaean design strengthened that possibility.

". . . then he bored through [the planks] and fitted them to one another, and next hammered [the boat] with pegs and joints."

—*Odyssey*, Book V, lines 247-248

The question of the ship's nationality, always on our minds, became even more intriguing when we raised one of the 16 stone anchors we eventually uncovered from the wreck. Beneath the anchor we found an assortment of bronze axes, sickle blades, adzes, balance weights, and ballast stones. And below that lay an exposed portion of the ship's hull.

The hull section consisted of fir planks, each about ten inches wide and two inches thick, fastened together and to the fir keel by mortise-and-tenon joints pinned with hardwood pegs. This was the same method of construction used in a fourth-century B.C. ship excavated by my colleague Michael Katzev, off Kyrenia, Cyprus, between 1967 and 1969.*

*See "Resurrecting the Oldest Known Greek Ship," by Michael L. Katzev, June 1970 and "Last Harbor for the Oldest Ship," by Susan W. and Michael L. Katzev, November 1974, NATIONAL GEOGRAPHIC.

In thus pushing back our knowledge of seagoing ship construction by nearly a thousand years, we now know that ships at the time of the mythical Greek heroes such as Odysseus and Achilles were built in the same manner as later Greek and Roman vessels. And we know too that Homer's description of Odysseus' constructing a boat was accurate.

At the end of the 1984 season we covered the fragile planks of the ship's hull with sand to protect them during the coming winter, dismantled our camp ashore, and sailed for Bodrum.

The following summer Cemal directed nearly all of the excavation while I visited museums and archaeological sites on

Cyprus and in the Near East. I was eager to see and study Canaanite and Cypriot materials firsthand for comparison with those we had recovered. Finally in late August I returned to Ulu Burun and was delighted with the summer's results. Cemal took me through an impressive collection of newly excavated weapons, tools, beads, and pottery, and then said with a grin, "Guess what else we have?"

I grinned in return. "You haven't surprised me yet."

But in fact he did: For the first time we had recovered Egyptian artifacts from the wreck! Cemal proudly handed me a scarab of bone or ivory framed in gold and carved with ornamental hieroglyphs on its base (page 732).

By contrast, the hieroglyphs on the next artifact—a small rectangular plaque of greenish stone—could be read: "Ptah, Lord of Truth." Is it possible that someone on this voyage worshiped Ptah, who was not only an Egyptian creator of the

DRAMATIC CHANGES IN STYLE left contrasting motifs on a hematite seal. The original Mesopotamian design, cut about 1750 B.C., shows a king, a goddess, and a small priest, at left and right. Four centuries later a frightful griffin-demon and a warrior were added at center by an Assyrian artisan.

Raw ivory for the workshop

ROYAL HUNTS in Syria are evoked by a section of elephant tusk. Artisans fashioned the ivory into decorative containers to hold ointments and cosmetics. In a possible sequence (lower right) a bottom and lid were cut first. A bow drill then removed the solid interior, yielding a cylinder available for another use. When carving was complete, the bottom was attached with ivory pegs, and a disk was carved inside the lid to fit the rim.

Two hippopotamus teeth were also found on the wreck.

universe but also the patron god of craftsmen, especially metalsmiths?

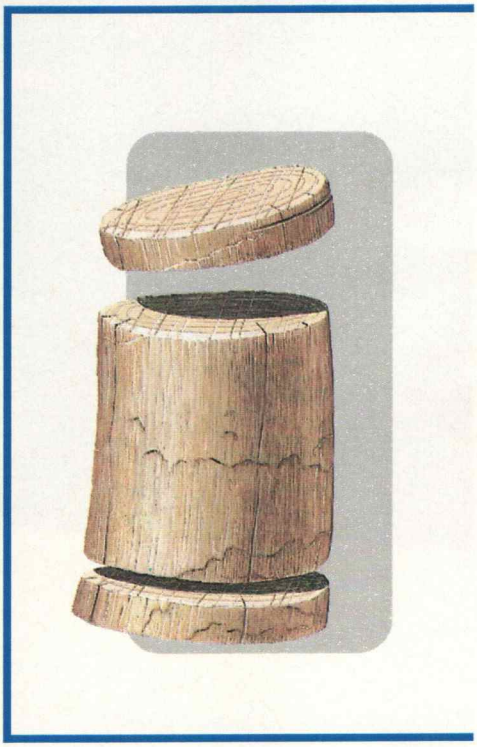
THAT SEASON added as many questions as it did clues to the nationality and character of our ancient ship's crew. Cemal showed me an Egyptian gold ring that had been cut in half with a chisel, thus rendering the text of the inscription on its bezel illegible. Our crew had already guessed why a damaged ring was on board. They had found other deliberately damaged jewelry such as halves of ornate gold pendants, some of them crumpled like pieces of paper, and a crushed gold flower. Twisted fragments of silver bracelets added proof that the ship carried a hoard of precious scrap metals.

I had hoped that the type and design of weapons, which might represent personal items of defense, would give us some hint at the nationality of our ship's crew. Two bronze swords of nearly identical size had been found that summer on the wreck, lying only a few feet apart. But one was distinctly Mycenaean and the other Canaanite!

Perhaps the crew of our ancient merchantman was as mixed as those aboard modern tramp steamers.

When we began the 1986 season at Ulu Burun, we thought we might have run out of archaeological firsts. We needn't have worried. As usual some of the surprises came from laboratories half a world away.

Most of the hundred Canaanite amphorae we had so far excavated had been filled with a yellow resin. Analysis by John S.



Mills of the National Gallery in London indicated that most or all the resin was from *Pistacia terebinthus* var. *atlantica,* a tree common throughout the eastern Mediterranean.

The resin was used for unknown purposes in Egyptian burial rites. How is it possible, I wondered, that the second most abundant substance in our ship's cargo, after copper, is something scarcely recorded in the Bronze Age?

"Payment to the palace, 1,320 liters of ki-ta-no; *still owed, 240+ liters."*

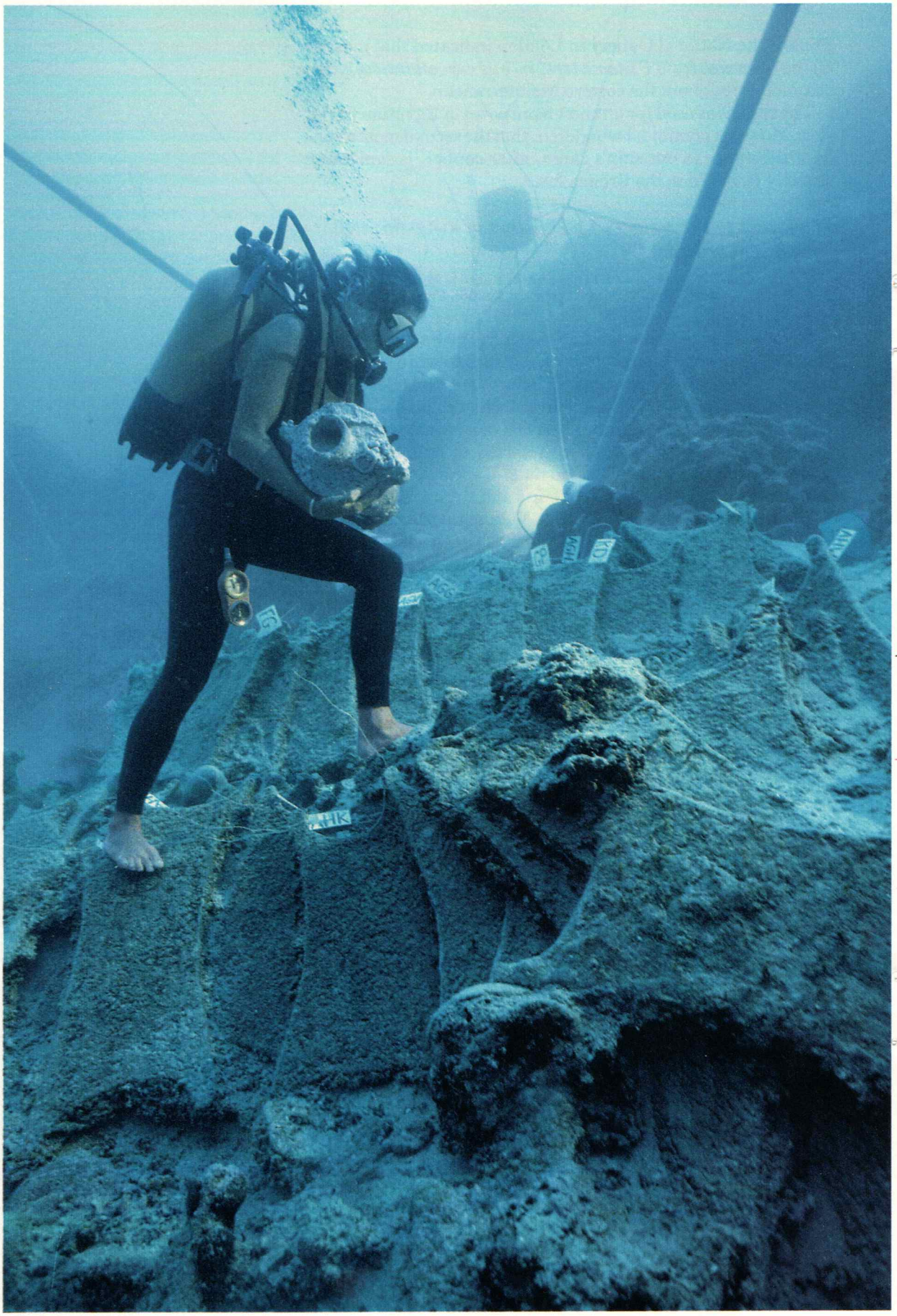
—Record of payment to royal stores, written in Mycenaean Greek on a clay tablet found in the palace at Knossos, Crete

By pure chance I later learned that a Spanish scholar named José L. Melena had interpreted the Mycenaean word *ki-ta-no* as meaning *Pistacia terebinthus*. Scholars were puzzled by the enormous quantities of ki-ta-no inventoried on tablets excavated in Crete—more than 10,000 liters on one record alone. They presumed that the term ki-ta-no referred to nuts of the tree, which are related to our pistachio nuts. But no large quantities of *Pistacia* nuts have ever been found at a Bronze Age site.

Weeks later my colleague Cynthia W. Shelmerdine, a specialist in Mycenaean Greek at the University of Texas at Austin, told me that the word ki-ta-no was written with a symbol suggesting that it was an aromatic or a condiment.

It therefore appears that since the Ulu Burun ship was carrying a very large consignment of *Pistacia* resin—not nuts—the tablets at Knossos likewise refer to huge quantities of the resin. Was it used millennia ago just as it is today, in the making of perfume, and was it thus considered a very valuable substance? If so, we have one more indication of the enormous loss represented by the shipwreck at Ulu Burun.

DRAWINGS BY T. W. RUTLEDGE



"One hundred pieces of ebony I have dispatched."

—Tablet from Amenhotep III to King Tarkhundaradu of Arzawa, found at Tell el-Amarna

EARLY IN THE 1986 SEASON Cemal showed me another of those uncanny discoveries of his. He had seen hundreds of tiny opercula, the button-like plates attached to the feet of murex and many other mollusks. Although the shells were absent, I argued that the opercula were natural to the seabed, like countless shells we removed routinely from the wreck.

But Cemal knew better. He showed me that the opercula were arranged in recognizable patterns and thus had been stowed by human hands.

We later learned that opercula were an ingredient of ancient incense. Perhaps they were also a by-product of the Canaanite industry that extracted the legendary Tyrian purple dye from murex glands.

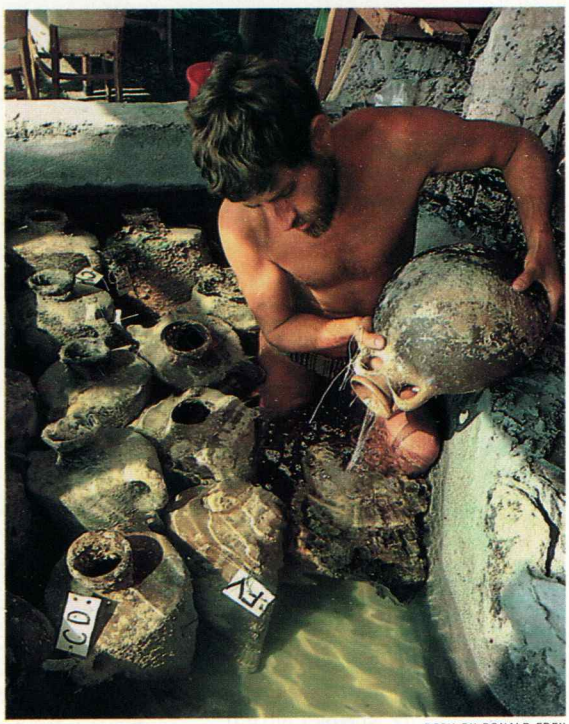
The 1986 season also produced fragments of tortoiseshell from the wreck—perhaps part of the sound box for a lute, the stringed instrument popular in ancient Egypt. We had already recovered a pair of small bronze cymbals only slightly larger than the finger cymbals used by modern belly dancers. Did musicians sail aboard ancient merchant ships? We know from records that they accompanied donkey caravans on overland treks in the Near East.

In 1985 we had found a number of dark logs on the wreck, the largest a yard long. I assumed they were ebony, one more of those raw materials shown in Egyptian tomb paintings being brought as tribute to the pharaoh, from lands to the south such as Nubia. But not till 1986 did we send a sample to Donna Christensen at the Center for Wood Anatomy Research of the U. S. Forest Products Laboratory in Madison, Wisconsin. Within a week Donna was on the telephone.

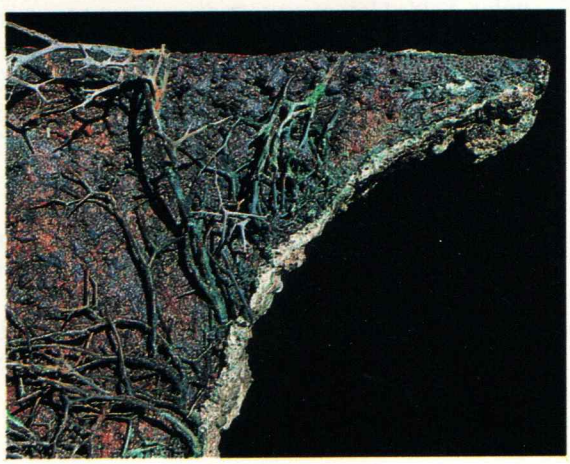
"Your logs aren't true ebony," she said, "they're African blackwood. The scientific name is *Dalbergia melanoxylon,* and the tree grows from Sudan as far south as Mozambique and Angola."

I was disappointed. I'd wanted badly for our logs to be ebony. But I later turned to my library and got a surprise. I found that what the Egyptians called *hbny,* or ebony—the same word we use today but for a different tree—was in fact *Dalbergia melanoxylon.* It is the same wood used in an elegant bed, a chair, and a stool in Tutankhamun's tomb. So we had our Egyptian connection after all.

GENTLY ASCENDING a staircase of copper ingots, Nicolle Hirschfeld removes an amphora from the wreck (facing page). The underside of an ingot found at the bottom of one stack still bears strands of thorny burnet (bottom), a shrub used as dunnage. Ashore in a storage basin Michael Halpern (below) empties a Canaanite pilgrim flask, as amphorae already inspected for their contents soak in water to prevent splitting. All artifacts are moved to their permanent home in the Bodrum Museum of Underwater Archaeology.



BOTH BY DONALD FREY



". . . fourteen seals of beautiful hulalu [*stone*], *overlaid with gold."*

—Gifts listed on a tablet from King Tushratta of Mitanni to Pharaoh Akhenaten, found at Tell el-Amarna

Tufan Turanlı's area of the wreck now became the center of attention. Working in the space of only a few square feet, he first recovered a gold pendant with the figure of a nude goddess holding a gazelle in each hand (page 718). The pendant is remarkably similar to one found at the ancient site of Ugarit in Syria.

Tufan continued working, removing the sand almost a grain at a time with a paintbrush and sucking it away with a tiny air lift. He soon found a second, smaller pendant with the lightly scratched figure of a woman wearing a dress with a flounced skirt. The figure reminded me of a portrait of a Canaanite merchant's wife I had seen in an Egyptian tomb painting.

Many a Near Eastern merchant carried a cylindrical seal that he could roll out on clay documents as his signature. Tufan's area soon yielded a seal made of quartz, or rock crystal (page 723), its gold caps reminiscent of those favored by the Kassites, the foreign invaders who ruled Babylonia around the period when our ship sank.

Tufan's second seal was made of hematite, an iron ore (pages 724-5). I sent drawings and photographs of it to Dominique Collon, an authority on seals at the British Museum, and some weeks later she gave me her report.

"I believe the seal was first cut in Mesopotamia in the 18th century B.C.," she said. "The original scene is quite worn and depicts a king facing a goddess, with the small figure of a priest between them.

"Much later," Dominique added, "probably in the 14th century B.C., in Assyria, a new scene was engraved over part of the old one. The new scene shows a winged griffin-demon and a warrior with a sickle-shaped sword. The later engraving has all but erased a cuneiform inscription alongside the old scene."

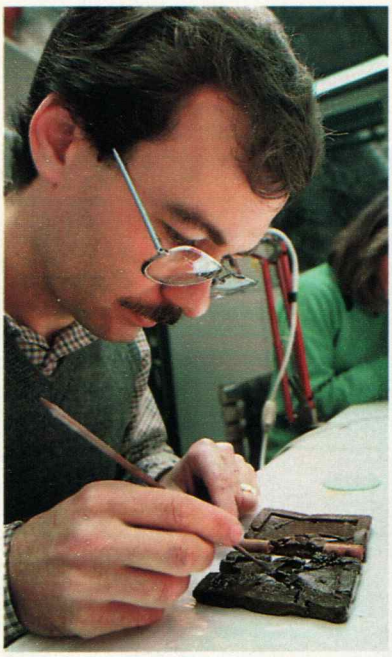
". . . he sent him to Lycia and gave him baneful signs in a folding wooden tablet."

—*Iliad*, Book VI, line 169

In all of Homer the only certain reference to writing is that single, puzzling line. Hinged wooden writing tablets, or diptychs, could be folded shut to protect the writing inscribed on their waxed inner surfaces. But no diptych had ever been found as early as the Bronze Age about which Homer wrote.

I thought it only a routine task when I asked one of our students from Texas A&M, Nicolle Hirschfeld, to remove and bring up the sediment from one of the remaining huge storage jars. Cheryl Haldane found that the jar had contained mostly whole pomegranates. But Cemal, sifting through the sediment in camp, found tiny fragments of wood that he began to piece together.

"It's a writing tablet, George," he declared, "the kind they spread wax on."

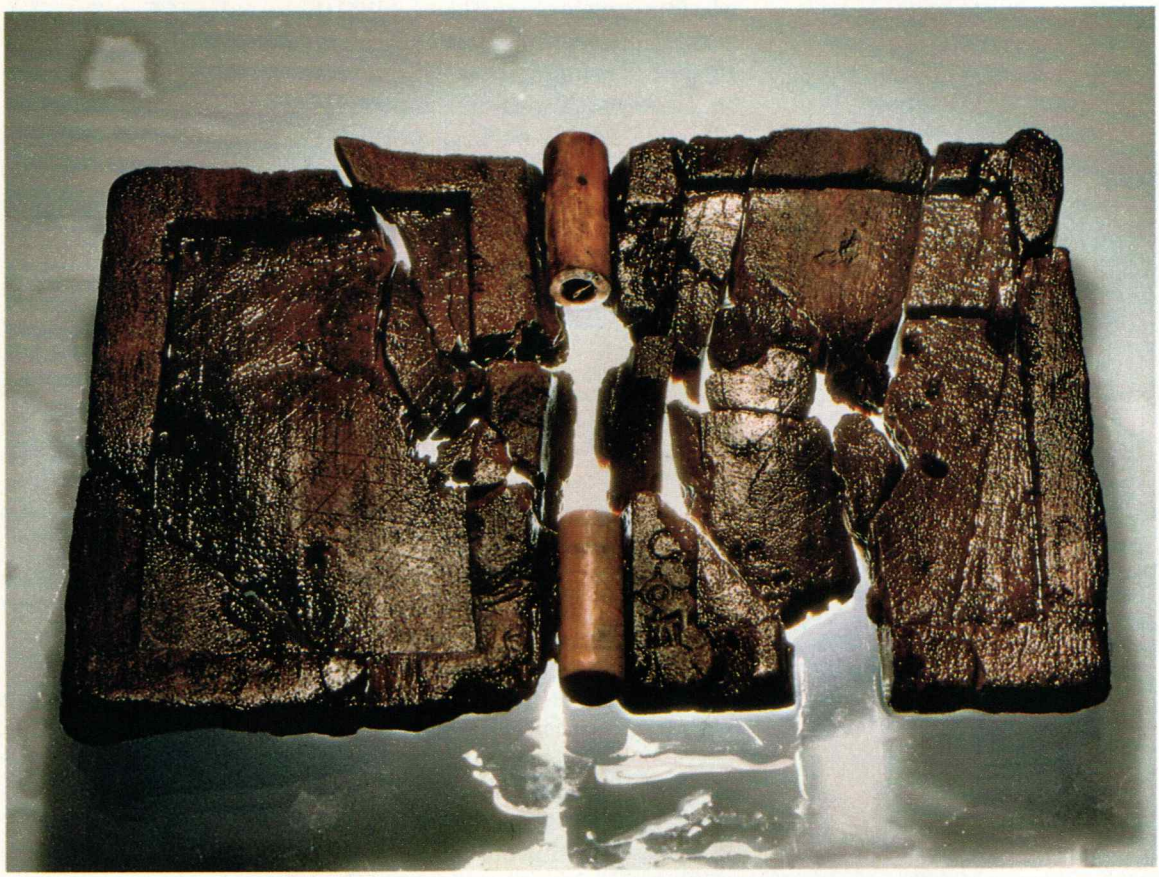


OLDEST "BOOK" ever found, a folding tablet called a diptych—the first from the Bronze Age—is cleaned by INA conservator Robert Payton (above). Two ivory-hinged wooden leaves (facing page) were recessed to hold beeswax, scribed with a stylus. Folded leaves protected the writing. Alas, the message from antiquity that might have been was not to be, for no wax remained. Library research showed that in later times orpiment, a mineral that had been found in one amphora, was mixed with writing wax for consistency and color.

The painstakingly assembled fragments formed two wooden leaves joined by an ivory hinge (below). The recessed inner faces of the leaves were scored with crosshatched lines, obviously to hold the beeswax, which was inscribed with a stylus. But no wax remained on the fragments of tablet.

Later in the United States my old friend Professor David I. Owen of Cornell University, who has excavated a number of sites with me, told me of several similar tablets that had been found in a well at Nimrud in Assyria and that until now had been considered the world's oldest known "books."

The wax on the Nimrud tablets had been inscribed with an



astrological text in cuneiform writing. Analysis of the wax showed it was mixed with 25 percent orpiment, or a yellow sulfide of arsenic, to give it the proper consistency and color. One of the first things we had recovered from the Ulu Burun wreck was the Canaanite amphora filled with orpiment. Now we may surmise its purpose on the wreck.

"The Beautiful One is come"

—Literal translation of the name Nefertiti

Tufan saved the best for last. One morning he surfaced with the small plastic box he stored his treasures in and lifted out a

solid gold scarab (below). As we do with all our finds, we photographed the scarab, and I later took the slides back to Texas.

It has been more than 30 years since I studied hieroglyphics, but with the help of an Egyptian dictionary I translated the end of the inscription on the base of the golden beetle: "Nefertiti."

Nefertiti! Is there a more beautiful face from antiquity than that of Pharaoh Akhenaten's great queen? Her timeless features have been captured for eternity in the exquisite bust from Tell el-Amarna (page 700).

Temple inscriptions record the fact that Nefertiti was an important figure in her husband's reign, but just how important has been a question in modern times. Some scholars believe she was immensely powerful, possibly the co-ruler of Egypt.

I sent photographs of the scarab to James Weinstein, a distinguished Egyptologist at Ithaca, New York, who has always been enormously kind in sharing his expertise. After weeks of careful research he called me with the startling news: Not only was this the first gold scarab ever found of "the Exquisite Beauty of the Aten [sun disk] Nefertiti," as her full name is translated; it also was the first artifact found in Asia Minor or the Aegean that names either the famous Akhenaten or his beautiful wife.

Even more important, the form in which Nefertiti's name is written on the scarab strengthens the theory that she ruled alongside her husband. What Egyptologist, enduring a cruel sun in pith helmet and desert boots, could have imagined such a discovery coming from the cool blue sea?

Was the scarab carried by an envoy of Nefertiti? We can only guess. The scarab is well worn. Cemal's map of the wreck site shows that it was found near the scrap gold, suggesting that it may have belonged to the same hoard. If it did, the ship sank after Nefertiti's death, for one cannot imagine her scarab's being discarded during her reign. That would date the ship much later in the 14th century B.C. than suggested by the Mycenaean cup we had found in 1984.

"GOLD IS AS PLENTIFUL as dust" in Egypt, a king wrote Pharaoh Amenhotep III in a plea for gifts. *A scarab, top left—the first found in gold—bears the title of the next pharaoh's queen, Nefertiti. Other scarabs bear only decorative signs, and a gold ring fragment was scrap.*

DONALD FREY

Cemal Pulak measures mortise-and-tenon joints in planks near the keel (facing page). From this oldest known shipwreck may come secrets as precious as the pharaoh's gold.

WE TRY NOT to speculate on the exact date or nationality of the wreck. It's hard not to, but after all, we've dug only half the site so far.

For the moment it's enough to savor the ship as an archaeologist's dream come true. But even I would never have imagined a site with such an abundance of new information for scholars from so many fields—Egyptologists, geographers, Homeric scholars, students of ancient metallurgy, glass, ship construction, sea trade, agriculture, art, and religion.

In short, we are salvaging the greatest of all treasures—the treasure of knowledge. □

Specializing in underwater photography, **Bill Curtsinger** has photographed more than a dozen magazine articles. He most recently described the sea life beneath the ice at McMurdo Sound in Antarctica.

DAN

Sea Change in the Sea Islands

"Nowhere to Lay Down Weary Head"

By CHARLES L. BLOCKSON

Photographs by KAREN KASMAUSKI

NOWADAYS Verneda ("Rikki") Lights, M.D., a graduate of Bryn Mawr College and of the University of Pennsylvania School of Medicine, practices in Philadelphia. But in the 1950s, when she was a small girl in Charleston, South Carolina, she was passed over the coffin of her great-grandmother so that she would be free of fear in accepting the mystical powers the old woman had specifically bequeathed to her. Rikki's ancestress, like many other black mainlanders on the Southeast coast, had embraced the traditions and customs deeply embedded in the Sea Islands, just offshore. Rikki's family moved there—to the island of Port Royal—three years after the old woman died.

"My great-grandmother came from a community of Christian mystics," Dr. Lights explains. "In the islands we all took it for granted that there were spirits, and we had to get rid of the hostile ones."

Dr. Lights, who is descended from West Africans transported to America as slaves, has never doubted that the powers that she inherited are real. Her great-grandmother, a practical nurse and midwife who was expert in the use of medicinal herbs, was famous for her clairvoyance. Dr. Lights herself has a gift for medical diagnosis in internal medicine—a gift, she says, that came from God.

The physician feels that her inheritance has strengthened her natural talent for music and poetry and that the spirit of her island and ancestors is a strong presence in her personal and professional life. "For me there is no separation between medicine and poetry," she told me in the cool tones of a modern scholar as we discussed the treatment of cancer patients with the latest drugs. The miracles of modern medicine, Dr. Lights

CLOSED OUT of her birthplace on South Carolina's Kiawah Island, Dolly Green stands outside Vanderhorst Plantation, where her grandparents were slaves. Gates also limit access to a black cemetery on Sea Pines (above), an exclusive enclave on Hilton Head Island. Those visiting buried kin may enter, but the need to ask for a pass affronts black islanders who see their land and life-style lose ground to development. Says one: "I been swallerin' bitter pills and chewin' dry bones."

believes, are every bit as wondrous as the feats of her long-ago neighbor on Port Royal, who would give Rikki's mother "flowers hexed, which would never die."

The latter phrase was spoken in Gullah, the headlong Sea Islands Creole that mixes English words and syntax with those from the Caribbean and especially West Africa to create a speech that is all but incomprehensible to outsiders, including blacks who may live only a few miles away on the mainland.

Charles L. Blockson wrote about the Underground Railroad in the July 1984 GEOGRAPHIC. Photographer **Karen Kasmauski** is a frequent contributor to the magazine.

This tongue, sometimes called Geechee, is an important reason why Sea Islanders have preserved a way of life that remains African in some of its essentials.

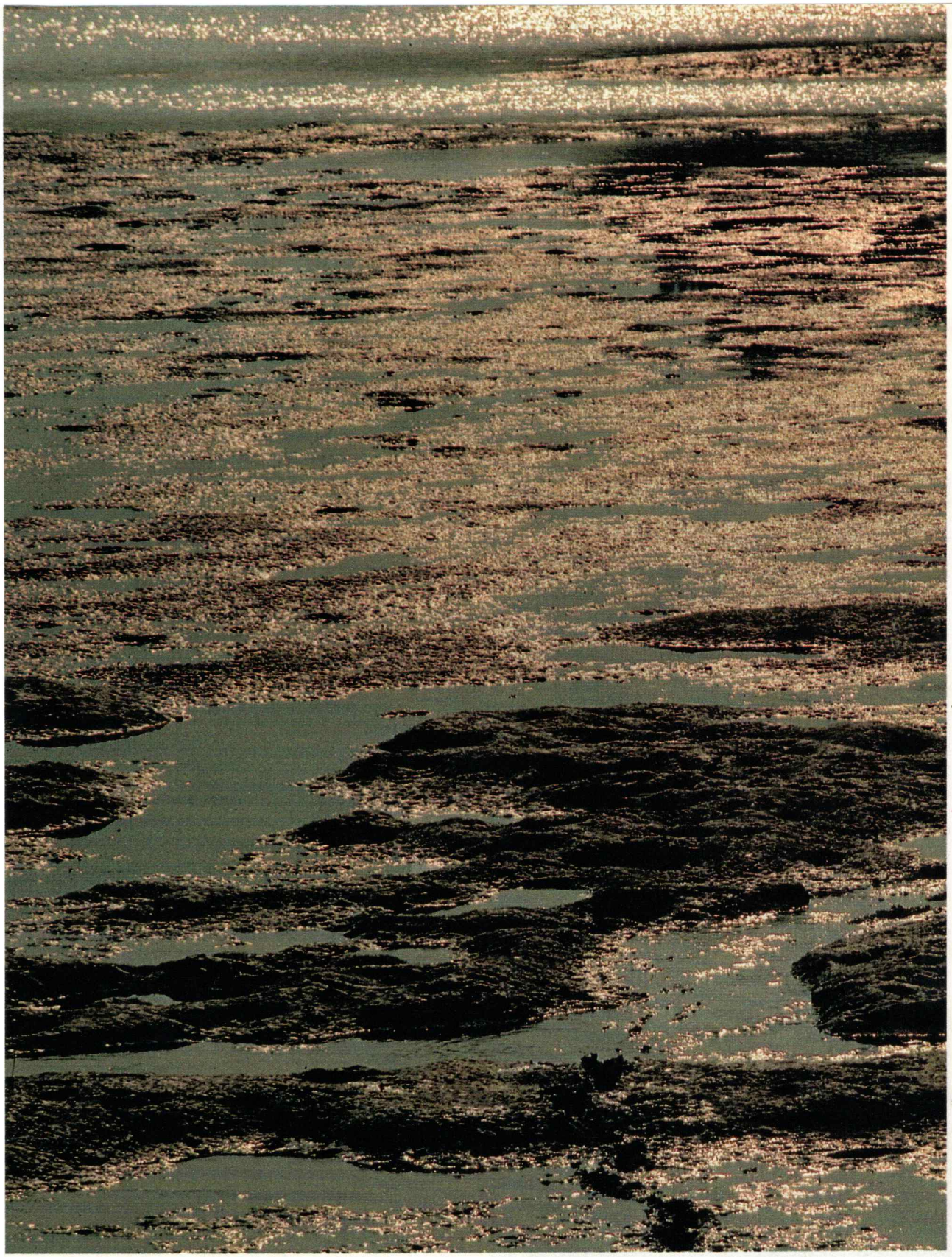
Like many another Sea Islander, Dr. Lights fears that the world of her ancestors, which survived more or less intact into her own childhood, is fading away. Booming development is changing life in the Sea Islands, displacing people who have in many cases lived on family land for generations.

"The situation is horrendous!" says Dr. Lights. "The islands have become a playground for white people. But this will not conquer the spirits of those whom the Lord has spoken to! The land knows who it belongs to."

I HEARD this emotional, evangelical tone in many voices this past year as I traveled up and down the Sea Islands, those low-lying, marshy barrier islands that hug the coast of South Carolina and Georgia (map, page 745). In *When Roots Die,* her remarkable book about the life and language of the Sea Islands, the late Dr. Patricia Jones-Jackson explained some of the reasons: "The extended family is the norm in the Sea Islands. Most islands are sectioned off into family communities, where all members of one family, their close relatives, and people remotely related live or have a right to live. . . . Land is not normally sold to family members but is passed on through an unwritten contract called 'heir's land.' "

Island tradition also places great importance on burial in home ground, and islanders will pay all their lives on insurance policies designed to provide for funerals that may cost many thousands of dollars. Many still living in the islands believe that a person is composed of three parts—body, soul, and spirit. When the body dies, the

IN A FINAL AMEN an infant is passed over her grandfather's coffin, a West African custom to prevent his spirit from bothering her. In a hallelujah to life the Reverend Ben Williams, with staff (top), leads some of his flock to a river baptism on Hilton Head Island. "Man, you must go under the water to receive the Holy Ghost . . . none of that sprinkling stuff," a Charleston deacon told the author.



HUSTLING THE MARSH for crabs, 12-year-old Taj Linen goes bogging on Wadmalaw Island. Bogging is best done at low tide, when crabs are stranded in pools. But the tide sneaks in treacherously. To be ignorant

of "ocean time" is to risk death. To this day most of the Sea Islands remain remote and inaccessible, enabling blacks to retain their Gullah speech—an African-influenced Creole that shapes and defines the culture.

soul departs, but the spirit remains behind and is capable of doing good or mischief to the living. As in West Africa, graves in the Sea Islands traditionally have been adorned with belongings of the departed, and with charms designed to contain or placate the spirit of the person buried there. Real or imagined threats to graveyards are, therefore, a cause of disquiet.

The island people long lived in isolation, and many of their customs and beliefs closely resemble those of the Ibo, Yoruba, Kongo, Mandinka, and other West African tribes from whom they probably descend.

SIGNS OF DEVELOPMENT, and reactions to it, are particularly vivid on Daufuskie. Three-quarters of Daufuskie, a particularly lovely island lying off Savannah, has been earmarked for development over the next 20 years, and two large tracts totaling 1,798 acres, or 29 percent of the island's surface, are already being developed to include more than 900 new homes, two inns, two golf courses, two tennis clubs, and two beach clubs, along with buildings for community services.

Local government officials estimate that "buildout," or the completed development of Daufuskie, will result in a population of 10,000 permanent residents in addition to a seasonal and part-time population of 10,000. Daufuskie's population in the 1980 census was 59, of whom 45 were black.

Property values were inflated dramatically by the development plan. A lot that may have been worth almost nothing rose in value to as much as $50,000 depending on its location.

"Yayman!" says Thomas Stafford, who makes his living on Daufuskie as a crab fisherman. "Money talks and you know what walks—some people can't wait to leave!" Thickets of For Sale signs sprang up over the island and are still to be seen.

SPECIAL DELIVERY: During the 1940s and '50s, Agnes Brown, now 89, delivered most residents of Wadmalaw Island, including Kerry Linen (facing page). "Sometimes they'd keep the car running, and she'd rush off to the next one," granddaughter Ruth Peterson recalls. Folk medicine came to these islands from Africa, as did a taste for plants like the elephant ear (above). Chefs Edna Lewis and Sylvester Holmes prepare the tubers as a side dish for the Restaurant at Middleton Place near Charleston.

But the sale of the heir's land is not always entirely voluntary. Under South Carolina law, heir's property (land whose title is often clouded because the original owner died without having made a will) usually cannot be sold until the title is cleared, but heirs living on it must pay taxes in order to continue their residency. As development causes land to become more valuable, taxes rise. Consequently, the occupants of heir's land are sometimes obliged to sell it in order to pay taxes. Because all known heirs must relinquish their interest in the land before title can be cleared, and because there may be hundreds of heirs to any given piece of land, the process is long, arduous, and fraught with emotion.

Most of the land on Daufuskie has been owned by whites since before the Civil War. In the days of slavery Daufuskie was divided into several large plantations growing

DROP BY ANYTIME, the door's open on Daufuskie Island, where houses stand in the dreamy embrace of oak and moss. Folks here visit at all hours to borrow a cup of sugar, swap tales, or just catch up on gossip. "We don't lock our doors," says one

resident, ". . . not yet." But the closeness shows signs of fraying. Daufuskie is blueprinted for large-scale development, and the native black population—1,000 strong at the turn of the century—has dwindled to barely 50 today.

Old-time talk we still de talkem here!

(We still speak Gullah here!)

MANY OLD WORDS and expressions are still in use among the Gullah speakers of the Sea Islands.

For example:

day clean: *daybreak*
ugly too much: *very ugly*
this side: *this island*
sweetmouth: *flatter*
one day mong all!: *finally!*
long eye: *envy*
small small: *very small*
small small small: *tiny*
I de shell em: *I am shelling them*
I ben shell em: *I shelled them*
I bina shell em: *I have been shelling them*
I ben don shell em: *I shelled them some time ago*

HUNDREDS OF WORDS derived from West African languages occur in Gullah, and some have crossbred with English to become common expressions. Here are a few of them, with the languages from which they may have come:

goober: "peanut" *(Kimbundu)*
gumbo: "okra" *(Tshiluba)*
heh: "yes" *(Vai)*
hoodoo: "bad luck" *(Hausa)*
yambi: "yam" *(Vai)*
chigger: "small flea" *(Wolof)*
nana: "grandmother" *(Twi)*
tote: "to carry" *(Kongo)*
biddy: "small chicken" *(Kongo)*
buckra: "white man" *(Ibo)*

CHARLES SESSOMS

"The Buzzard and the Hawk"

A GULLAH FOLKTALE, AS TOLD BY MR. TED WILLIAMS

You know the buzzard always was a—a nice educated animal, you know! E take e time—just like he done with the hawk.

Him and the hawk was sitting down on the limb one day, and he said—Him and the hawk had a consolation [consultation].

Say, "I'm very hungry!!!"
The hawk say, "I'm hungry too! Lord—O Lord!
My stomach! I too hungry!"
The buzzard say, "Wait on the Lord—"
And e look up—Nothing for dead—NOTHING, you know
So the buzzard say, "MAN!!!"

The hawk say, "I can't wait no longer!"

So when he look, a little sparrow come along. And—and—and the hawk get up and run at the sparrow and hit a tree *Uh huh!*

And the buzzard sit on he limb and look the hawk, look at the hawk, when he run into tree. The buzzard say, "I tell you wait on the Lord. Now I gone eat you now!"

PATRICIA JONES-JACKSON 1946-1986

WHEN PATRICIA JONES-JACKSON, a young doctoral candidate in linguistics from the University of Michigan, arrived in the Sea Islands, the first question she was asked was "Who is your mother?" Not until she was "adopted" as a "granddaughter" by a respected older woman did the people begin to accept her. Pat remained among them, intermittently, for 13 years, pursuing a scholarly passion for Gullah that also took her to West Africa in search of the roots of the language. Later Pat—an associate professor at Howard University—suggested a NATIONAL GEOGRAPHIC article about Gullah and the Sea Islands. The assignment, Pat's first for the magazine, ended in tragedy. On June 30, 1986, she died of injuries suffered in an automobile crash on Johns Island, South Carolina. The material about Gullah on this page is adapted from her posthumously published book, *When Roots Die,* and is reprinted by permission of the University of Georgia Press.

long-staple sea island cotton. Profits for the white owners were enormous—the supple, silky sea island cotton sold in European markets for more than twice the price of ordinary cotton. Union forces occupied Daufuskie early in the war. White owners abandoned their plantations, and blacks who had been their chattels were dispersed.

As the Confederacy collapsed, freed slaves moved into the Sea Islands in large numbers. On January 16, 1865, after meeting at Savannah with a delegation of black clergymen who pleaded for land for former slaves, Gen. William Tecumseh Sherman issued Special Field Order 15, ceding most of the Sea Islands in Georgia and South Carolina to them and declaring that no whites apart from military officers and others in helpful capacities were permitted to reside in the islands. After the war, however, President Andrew Johnson allowed plantation owners to return. Many former slaves nevertheless retained small holdings.

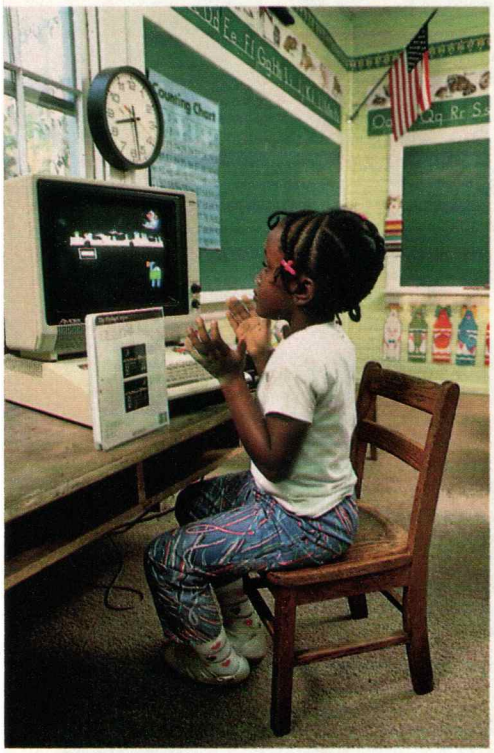
During Reconstruction two of the plantations on Daufuskie were subdivided into small tracts and sold to blacks who had moved onto the island, but the others remained under white ownership. A period of prosperity followed, based on sea island cotton, lumbering, and the rich oyster beds that surround Daufuskie. By the early years of the 20th century, a thousand blacks were residing there.

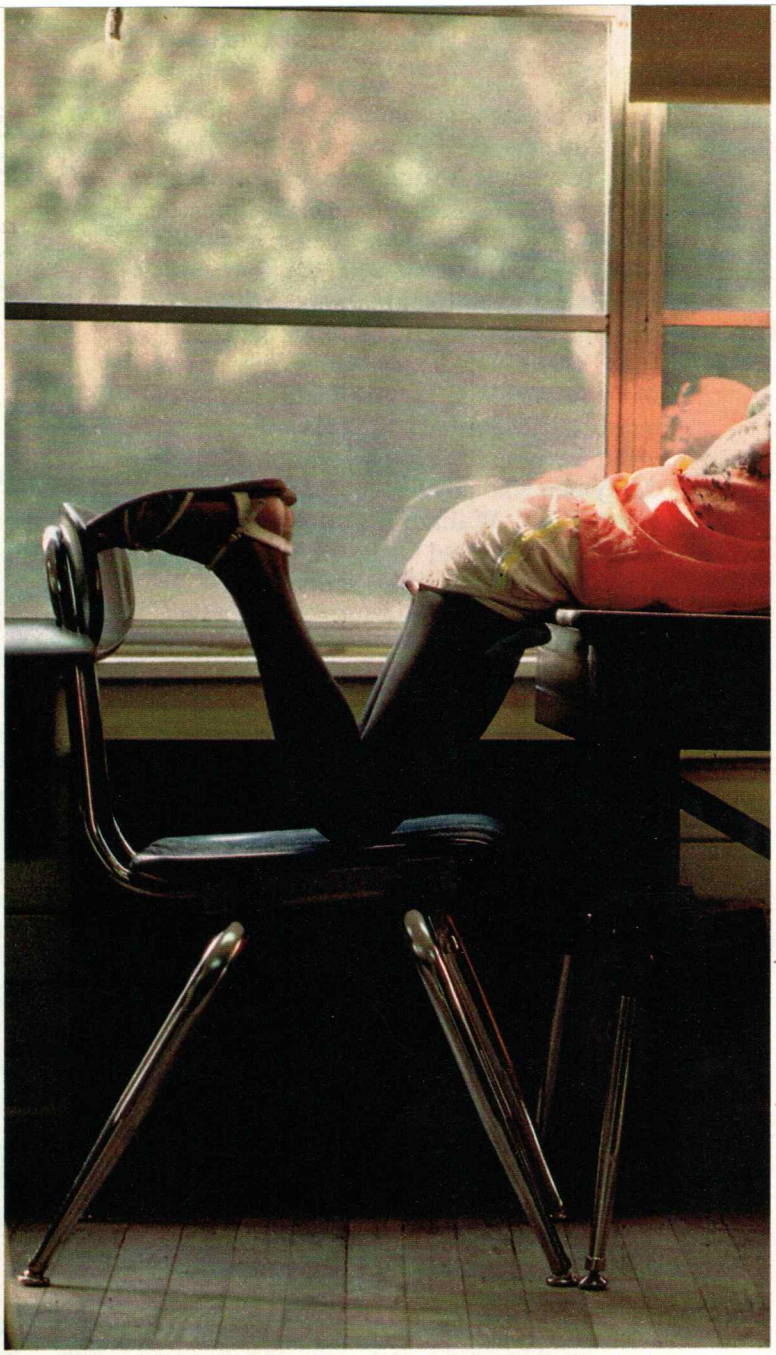
Then disaster struck. By the 1920s the boll weevil had destroyed the cotton industry. In the ensuing economic collapse, many black families sold their land to mainland investors and moved away, and by 1936 fewer than 300 blacks remained on Daufuskie.

THE MOSSY FRINGE of the Sea Islands edges a 250-mile stretch of southern coast. The islands, marshy lowland veined by tidal streams, number in the hundreds, perhaps thousands. Because the deep waterways offered good harbor, slaves were landed here from West Africa, or via the Caribbean, in a trade that continued as late as 1858. The slave population, by 1860 more than 400,000 in South Carolina alone, provided the muscle for plantations of rice, indigo, and cotton. During the Civil War, General Sherman issued Special Field Order 15, reserving land for former slaves. The order was widely ignored within a year, but many held on to their lands, bequeathing them to heirs.

"I CAME FOR A MONTH and stayed for ten years," says Dominican Sister Sharon Culhane, teacher of Daufuskie's only school, a two-room clapboard structure that mingles prekindergarten through sixth grade. Second graders Rakenya and McKinley Robinson have homework checked (right).

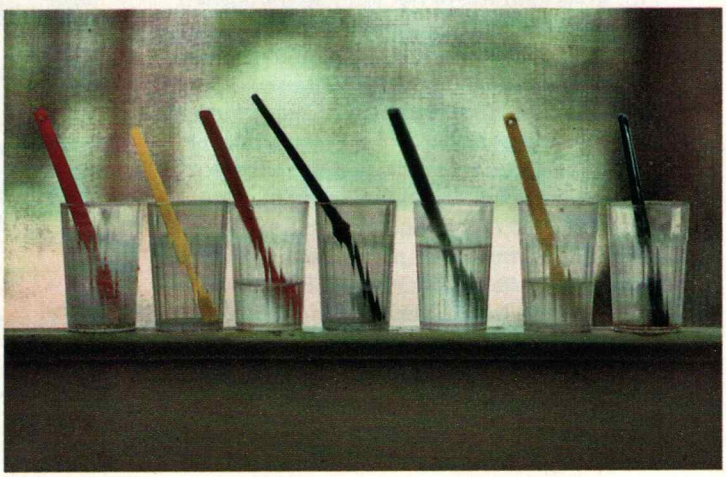
The curriculum includes the tried, true, and new. Sabrina Robinson, six, learns on a computer (below). Mascot Megan audits class (bottom right) and naps with the preschoolers. The school serves breakfast and lunch,





and then the lesson plan calls for toothbrushes (right).

Recently, thanks to Sister Sharon's firm, loving hand, the school won a state award for test scores and attendance. But sometimes friends move on. Last June, Sister Sharon took another job, on the mainland. "I won't say good-bye," one mother told Sister Sharon. "You're one of us."



WITH ALL OF SUMMER stretching ahead, the Daufuskie Island children and their friends from the mainland picnic on the beach to celebrate the last day of school. A pine tree's exposed roots testify to the forces of erosion.

Many worked at an oyster cannery, but it was closed down in the 1950s after industrial pollution from the Savannah River poisoned Daufuskie's oysters. The population fell steadily as residents departed in search of work and education.

OTHER ISLANDS have experienced similar declines. The exodus has been so marked that some community leaders, such as Bill Jenkins, the heir of a family long established on Johns Island, believe that black ownership of the land will likely be a thing of the past by the turn of the century. Those who do remain will be living under conditions that are quite different from the life described in the Gullah folktales, in which the simple adventures of the islanders almost always involve the soil and the animals—Brer Rabbit, Brer Gator, Brer Deer, the friendly porpoise who leads mullet into the net, the wise buzzard (a favorite creature among black islanders).

"Most people feel, what can we do?" says Tom Stafford. "Sure, I raised some hell at first, but now I don't feel a cuss about the damn pollution and the building that are changing everything."

An elaborate plan of development, approved by the local authorities, seeks to provide adequate protection against overbuilding and the pollution and other problems that can result from it. But golf courses and hotels and villas, pleasing though they may be to the investor and to the city dweller, are not as enchanting to those who grew up on the islands as the salt marsh, the piney woods full of birdsong, the lagoon teeming with ducks.

To the outsider's eye, the Sea Islands remain enchanting. Separated from the mainland and from one another by a system of tidal creeks and salty inlets, wide bays and marshes, they form magnificent beaches

and dunes and grow lovely forests of pine and live oak. Their names are pure music: Pawleys, Cedar, Murphy, Bull, Capers, Dewees, and the Isle of Palms off Charleston; then James and Johns, Kiawah, Wadmalaw, Edisto, famous Parris Island, Hilton Head, and Daufuskie, and on down to Tybee, Wassaw, Ossabaw, St. Catherines, Sapelo, St. Simons, Jekyll, and Cumberland at the Florida line.

I was charmed by these place-names, in which the languages of two or three continents tumble together. And I was charmed by the vast stretches of brown fields and moss-green marshes, charmed by the sandy beaches pounded by rhythmic surf; and I was charmed above all by the magnetic people of the Sea Islands.

THE FIRST PEOPLE were Indians—Guale and Cusabo—who inhabited the Sea Islands when they were "discovered" by the Spaniards in 1521. The first European colony in what is now the United States, predating St. Augustine in Florida by 39 years, was established by Spain in 1526 on the coast of South Carolina. Among the original settlers were the first black slaves, and they staged the first slave revolt. The colony failed. In time, other Spanish settlements and missions sprouted along the coast. All were eventually uprooted by the English, who founded Charleston in 1670. James Oglethorpe established Savannah in 1733 and crushed a last-gasp Spanish attack on St. Simons Island nine years later.

The whites who displaced the indigenous Indians were never numerous, but the black population grew apace. In 1835 a South Carolina grand jury complained that during the summer months (when mosquitos made life miserable) there were only 40 white proprietors to oversee a black population of 15,000 on the plantations around Georgetown. By 1860 South Carolina had a white population of 291,300, a slave population of 402,406, and 9,914 freed slaves.

The ratios did not yield to the passage of time. The 1940 census revealed that only 251 of the 1,858 inhabitants of Wadmalaw Island were white. Ratios were similar on other islands, but whites appear in some surprising historical footnotes: Aaron Burr took refuge on St. Simons after killing Alexander Hamilton in a duel, Edgar Allan Poe found the inspiration for "The Gold Bug" on Sullivans Island near Charleston.

Black history was recorded in an oral tradition that is typically African. Every islander, however young, is expected to know his own family history, and older people often subject newcomers, black or white, to a strict interrogation on their lineage. Parentage is the passport to trust and acceptance, and islanders can be cool, even hostile, to outsiders regardless of race. Most black islanders have two names—one for home use and another to be told to strangers. Some older residents are named for months or for days of the week, a system of naming that is common among West African peoples.

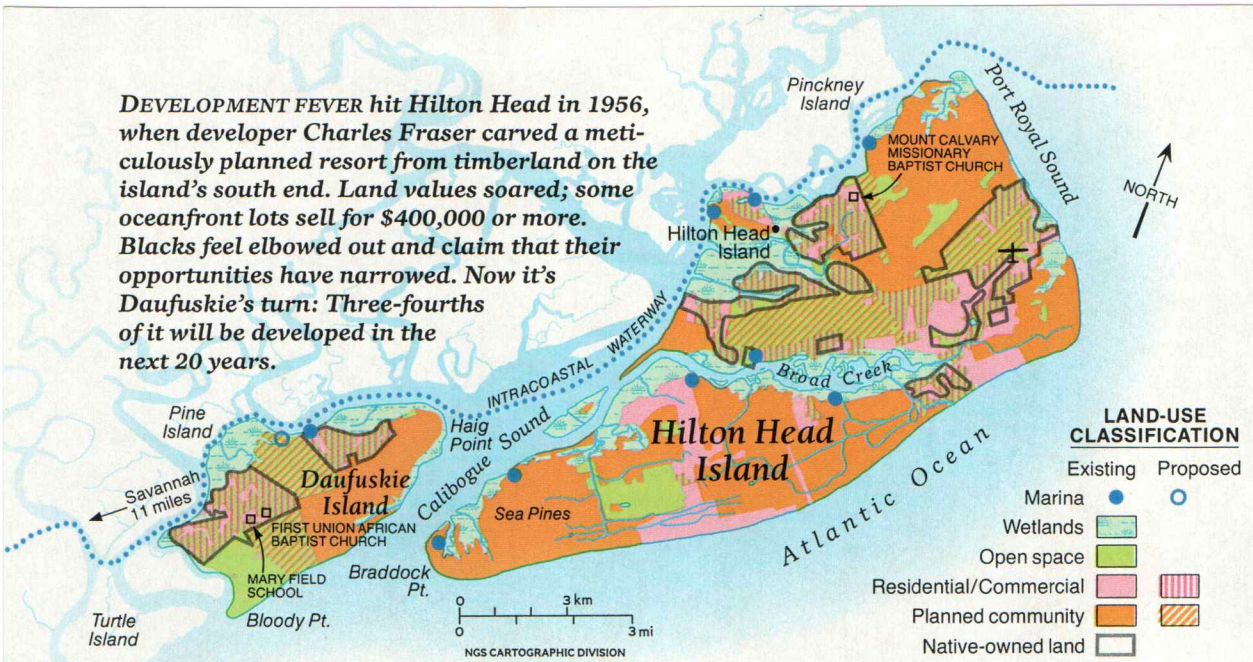
Today large tracts of private land are closed to everyone except those with permission to enter. In the opinion of Emory Campbell, the soft-spoken director of the Penn Center on St. Helena Island, the old cohesion of history and everyday life is coming to an end. Development, the latest in a long series of intrusions from the outside world, generally gets the blame. "Yayman! Something is slipping away," Mr. Campbell said. "We used to hunt, fish, and play at will. Now we need identification in order to enter certain areas."

IS THERE NO BRIGHT SIDE to recent events? Edward A. Chazal, vice president of International Paper Realty Corporation, suggests that the jobs created by development may make it economically possible for Sea Islanders to come back to the Sea Islands. "The children are coming home," he says, pointing out that his firm has created 140 jobs on Daufuskie. Nearly all of these, he concedes, are filled by workers who commute from the mainland.

Certainly development brought employment opportunities on Hilton Head, where development began in the 1950s. But Laura Bush of the Institute for Community Education and Training on Hilton Head maintains that there are few blacks in white-collar positions. "We have set up a system with Beaufort Technical College whereby we prepare students both for high-school equivalency tests and post-secondary education,

"I STAY RIGHT HERE," proclaims 85-year-old Virginia Bennett of Hilton Head Island. Five years ago a condominium pushed up in back of the acre plot she's lived on for 40 years. The land could bring a relative fortune, but she won't sell. Her late husband

built the house for her. "If she moved, she'd die the next day," a friend says. As hotels and golf courses proliferate, the cultural slippage accelerates. In 1950 nearly all Hilton Head residents were black. Today whites outnumber them eight to one.



***DEVELOPMENT FEVER** hit Hilton Head in 1956, when developer Charles Fraser carved a meticulously planned resort from timberland on the island's south end. Land values soared; some oceanfront lots sell for $400,000 or more. Blacks feel elbowed out and claim that their opportunities have narrowed. Now it's Daufuskie's turn: Three-fourths of it will be developed in the next 20 years.*

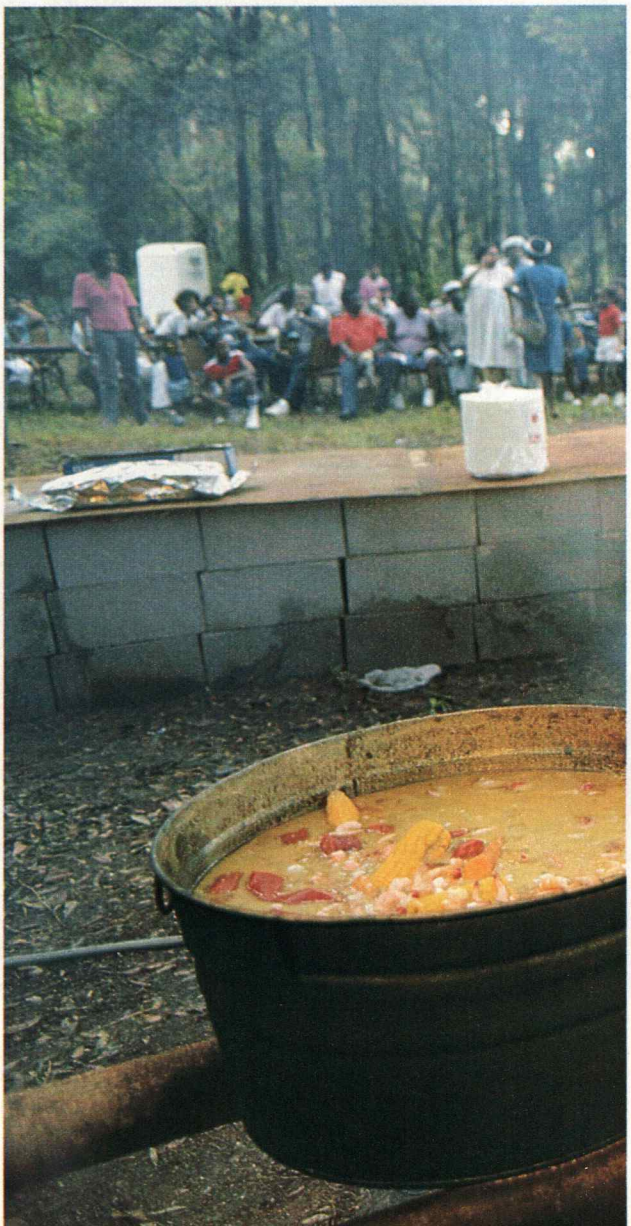
with the hope that they can move ahead into college level classes," says Mrs. Bush. But the 5,000 men and women who arrive daily on Hilton Head at 7 a.m. from five surrounding counties work in construction, service, landscape, cleaning, or maintenance.

Like Mr. Chazal, Donald Martin, former vice president and now a consultant for the Haig Point Realty Corporation, which has been building on Daufuskie since February 1985, sees the resort boom as a long-term source of jobs in the Sea Islands. "Everybody who wants to work can work," Martin says. "Inevitably there will be growth and therefore more jobs."

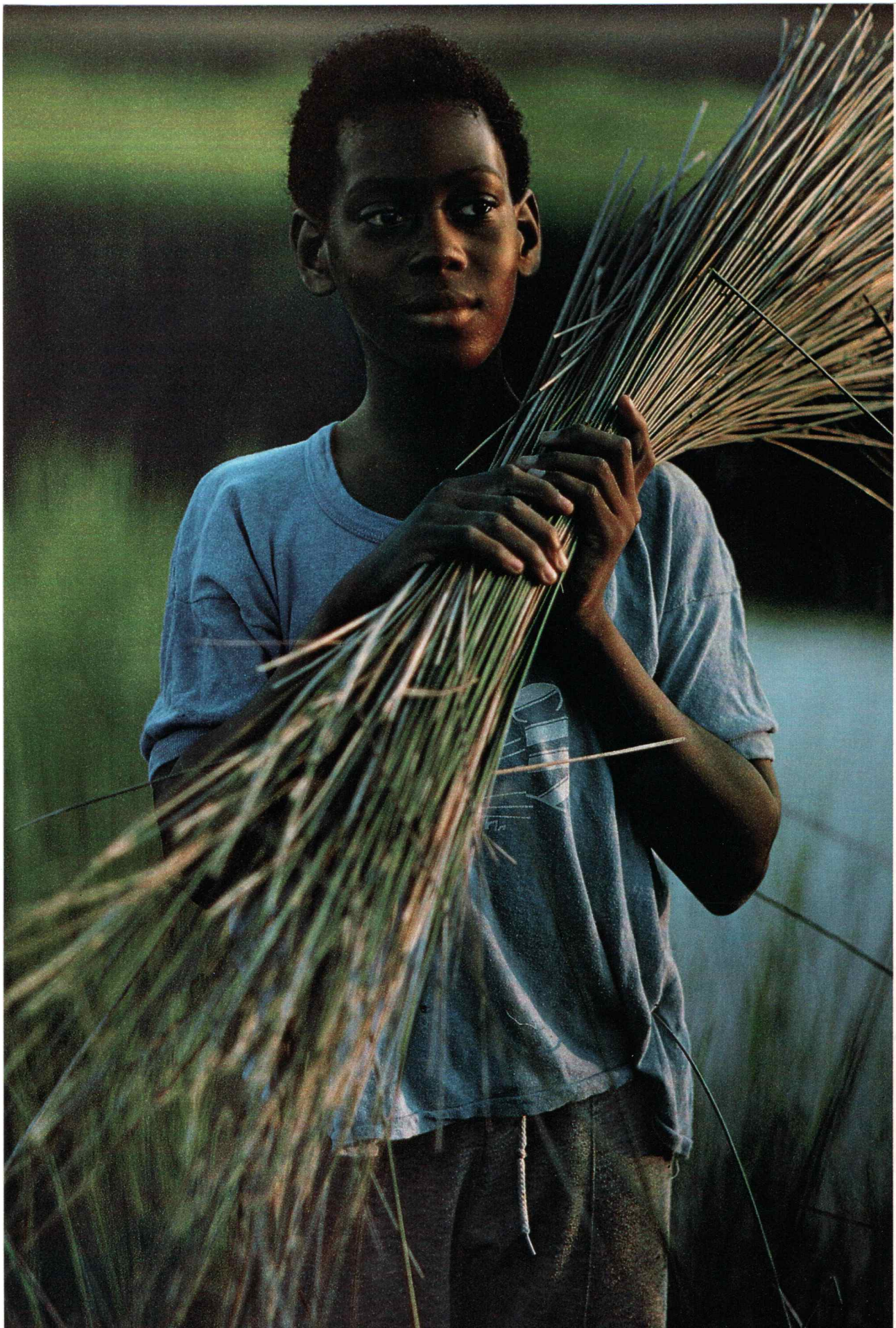
"We can tolerate what is happening so long as there is progress with pride," says the Reverend Benjamin Williams, pastor of the Mount Calvary Missionary Baptist Church on Hilton Head and member of the board of the Paralleled Land Owners Association. "But surely residents must be given the privilege of traveling about on the islands of their ancestors without showing identification."

BENEATH this tense and puzzled surface, old things survive. One elderly woman, who asked that her name not be published, told me, "We have love and understanding here—but I tell you, when the burden becomes too heavy to carry, we go to church."

Churchgoing on the islands is an inspiring experience, and as Dr. Jones-Jackson observed, the sound of singing and praising



A LOW COUNTRY BOIL of seafood and sausage simmers for 300 guests at the annual Williams family reunion on Hilton Head (below). Relatives attend from as far away as California and New England. Emory Campbell and Jesse Williams, Sr. (left), return from a memorial service at the cemetery. The far-flung family reflects a continuing exodus of black islanders in search of jobs and education. Developers argue that resorts create jobs that will encourage locals to stay. But blacks rebut that the jobs created are menial ones with negligible potential.



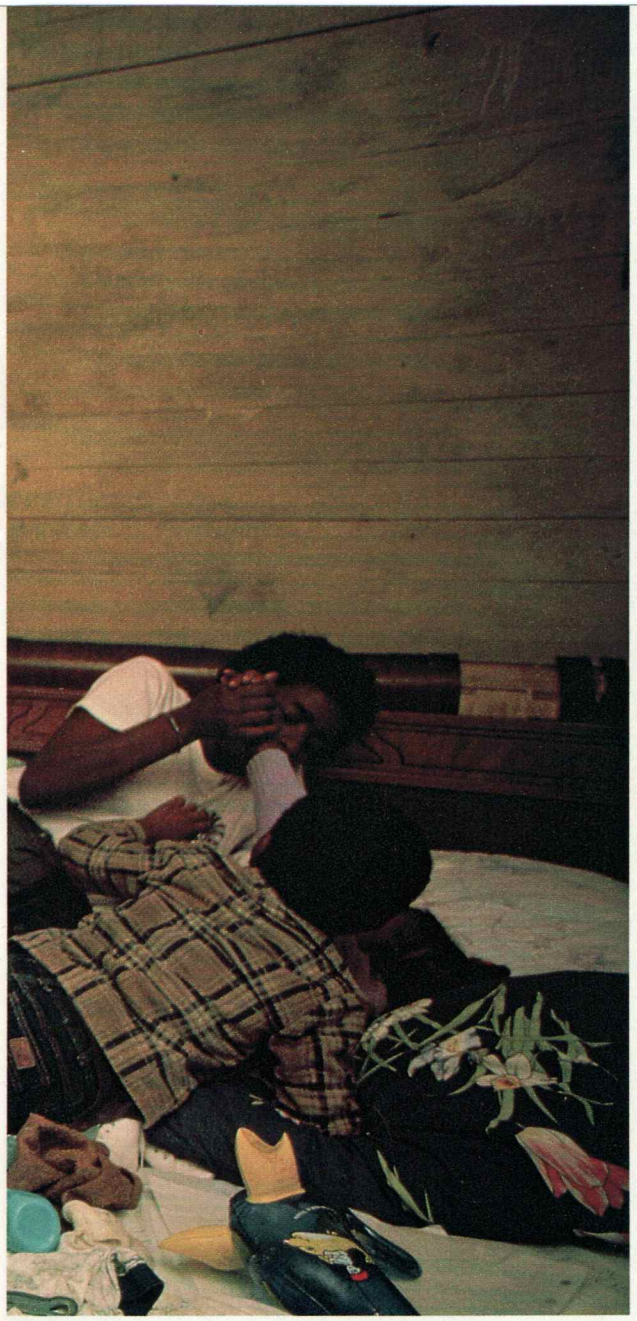
SHOULDERING A SHEAF of rush, Wendell Foreman (left) gathers weaving materials for his aunt, master basketmaker Mary Jackson (above, at left), who passes on her skills to her daughter, April. A display of Mrs. Jackson's baskets are exhibited at the Charleston airport (right). Basketry is one of the oldest African crafts practiced in the United States. Originally made for utilitarian use—winnowing grain, cradling infants, and storing food—such baskets are now prized by collectors. Those made by Mrs. Jackson can take three months. Sweet grass, a weaving material valued for its delicacy and pliability, is becoming difficult to obtain, as access to South Carolina's marshes is blocked by development.

can be heard from afar on Sunday morning. In her book she quoted this passage from a prayer in an island church:

> *As you say the foxes of the forest*
> *Got hole*
> *And then the birds of the air has nest*
> *Master, we are poor son of man*
> *Nowhere to lay down weary head.*

Mrs. Gillian Hinson-White spoke about other traditional activities. "I used to be the best shot on Fuskie," said Mrs. Hinson-White, who told me that she was 86 years old, five feet tall, and had always weighed exactly 98 pounds. "I could shoot alligators between the eyes. I buried two husbands on Fuskie, and now those folks talking about removing the cemetery. If the construction companies bother my husbands' graves, that is the day I'll put *them* in one."

Rikki Lights had told me about a plant known to black island residents as "life everlasting," whose dark leaves and stems can be boiled into an herbal tea to treat many ailments, including asthma. Elsewhere in the islands I had heard tales of hexes and other herbal remedies—mullein tea for curing colds, tinctures of wood chips and turpentine



SEALED WITH A KISS, the loving compact between kin is shared by young Thomas and his mother, Sallie Ann Coleman, president of a community action group on Daufuskie Island. A mystical seal, a pyramid, graces a chimney in McClellanville. "It's the Egypt in me," says Eugenia Deas. And the blue window frame? "I just like the color," she says. But island lore says blue wards off evil hags.

for purging the system, secret roots used by midwives, poke leaves for sprains, leaves from the lily bush for sweating out fever.

When I asked Mrs. Hinson-White about these matters, she gave me a searching look and responded with caution: "Yes, there were a few root doctors—years ago. Some people believed in ghosts, hexes, and roots. Sheriff McTeer and Dr. Buzzard were good witch doctors who made a lot of money."

I had heard that blue paint was much in demand in the Sea Islands because it is supposed to protect the home from evil spirits. "That's right," said Mrs. Hinson-White tartly, "but my house isn't painted blue."

Many others are.

DOUBTLESS preparation of herbal medicine and the use of incantation and witchcraft were brought to the islands from Africa. Such practices have been persistent features of Sea Island culture, and they did not always work for the good.

Many believed, and still believe, that malevolent juju men could "put de mout [mouth] on you," as bewitchment is called. In any case the picturesque terminology of

THE COURAGE of their convictions inspired Charlestonians Septima Clark (facing page, seated) and Bernice Robinson, the first teachers at the nation's first citizenship school, begun on Johns Island in 1957 to enable blacks to get voter-registration cards. The constancy of affection has kept the Reverend John Chaplin and wife Janie (below), of St. Helena Island, sweethearts for 60 years. They met in grade school and had their first date at the farmers' fair.

Sea Island superstition and folklore is still in everyday use: "When you hear the pig hollering, it's going to rain," the islanders will say. Or "hang a bottle in the tree to keep evil spirits away. . . . Pour turpentine, kerosene, or lime around your gate to keep off poisonous snakes. . . . Plant a cedar tree near the grave. . . . To put a curse on someone, mix up ashes and chicken feathers."

H. L. Mencken, among others, wrote contemptuously of Gullah. Other scholars thought differently, and as long ago as 1949 a linguist reported that he had identified 6,000 names and other words of African origin in the speech of the islanders. Professor William Stewart of the City University of New York has estimated that about 250,000 Gullah speakers live in the United States, including some 10,000 in New York City.

Dr. Jones-Jackson collected many Gullah words in common use that have survived intact or have been derived from such West African languages as Kongo, Kimbundu, Vai, Twi, and Ga (page 744).

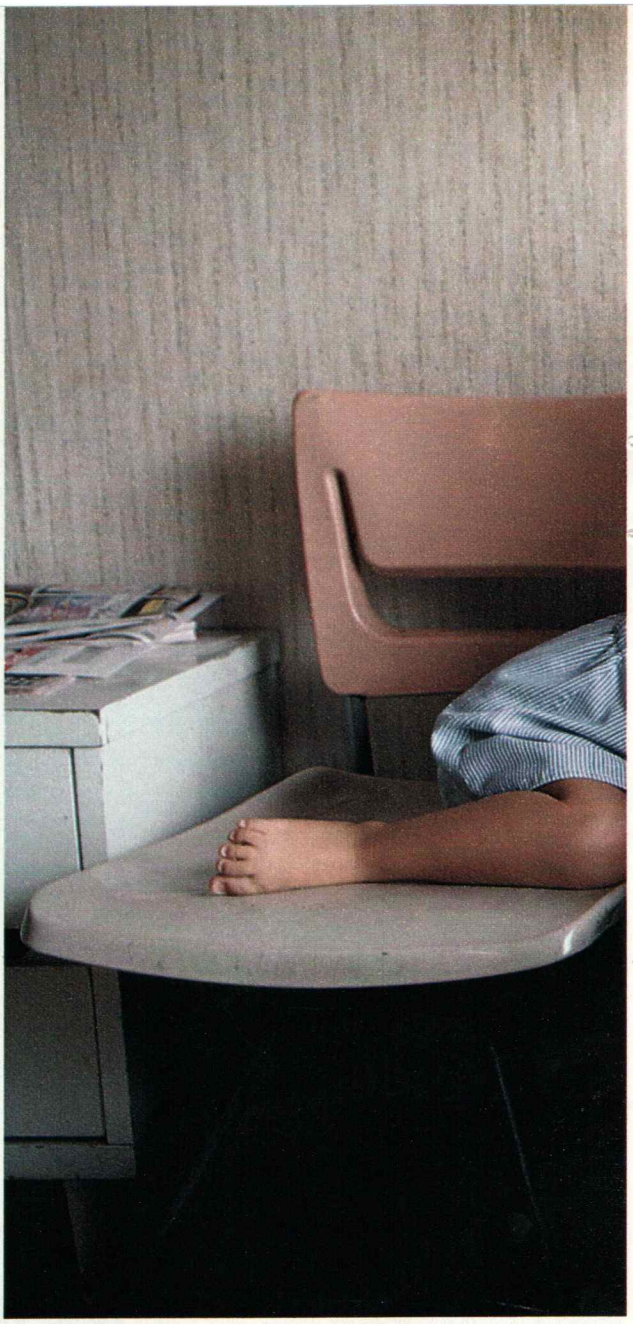
The Reverend Ervin Greene, pastor of Brick Baptist Church on St. Helena and former pastor of First Union African Baptist Church on Daufuskie, has been working with other scholars for nine years to translate the Bible into Gullah.

Mr. Greene believes that Gullah is related to the Creole spoken in the Caribbean. Grady Lights, brother of Dr. Rikki Lights, recalled from his school days that Gullah-speaking students had little problem learning a foreign language, but sometimes had difficulty with standard English. When I asked Grady about the difference between Gullah and Geechee, he smiled. "Folks down the coast speak at a faster clip than we do," he said. "We seldom used the word 'Geechee' in their presence because it had somehow come to mean, well—hick. So if we did, we'd also say, 'Prepare yourself for battle.'"

SOMETIMES, after talking over old times and new times with the islanders, I would find myself thinking about ancient peoples who lost their history and died. Then the vitality of the islanders would wake me to reality. At the sixth annual Penn School Heritage Celebration on St. Helena Island, pride, love, and smiles reflected the reigning mood of the interracial crowd. It was a feast—fish, oysters, clams, fried chicken, corn on the cob.

There was much talk of the history of the island. Strolling around the shady park, I recalled the contributions of Penn School founders Laura Towne and Ellen Murray, and Charlotte Forten, the first black teacher. These three and others were sent by missionary societies in the North to educate 10,000 newly emancipated slaves who lived on St. Helena Island. Soon schools began springing up on neighboring islands. Abolitionist poet John Greenleaf Whittier sent

A SHOULDER TO LEAN ON is the safe harbor offered two-year-old Lindsay Barry by her sitter, Helen Bryan, netmaker and wife of a Hilton Head oysterman. But outside, a traditional way of life founders as development whittles away black land and culture. Islanders phrase it this way: "Everything change up now."



Charlotte Forten his "St. Helena Hymn" written for the scholars of St. Helena Island, occupied by Union troops. Charlotte taught her students to sing Whittier's verses for the Emancipation Proclamation exercise of January 1, 1863.

IN 1858, on Jekyll Island, the slave ship *Wanderer* debarked one of the last major cargoes of slaves ever to land in the United States. Jekyll, lying near the mouth of the Satilla River some 20 miles north of the Florida line, greeted me with a shower of warm rain and a great squawking flock of sea gulls, almost the first I had seen in the Sea Islands. At the turn of the century Jekyll was developed as the exclusive winter retreat for a group of northern industrialists. Some of the great houses that they built and filled with servants brought from Newport, Nantucket, or Southampton still look down stately avenues of live oaks.

If present-day luxury is something a person values, then he must not miss St. Simons, for here are exclusive country clubs, opulent private estates, marinas bristling with yachts. Fields where slaves toiled have been converted to emerald golf courses.

In a sense the slaves are still a presence here. It is said that a slave ship landed at high tide on a bank of Dunbar Creek. As the slaves were unloaded, they turned together and marched into the deep waters of the creek, chanting as they drowned: "The water brought us in, the water will take us away." Ghost hunters today say that the chant, and the clanking of chains, can still be heard on dark nights.

On nearby Cumberland Island I sought out more contradictions of history and human nature. There is a dewy freshness about Cumberland—waves of sand, great live oaks, vast stretches of green-brown earth. Here I walked among the ruined chimneys of slave quarters and meditated on the tall chimneys on Butler Island in which every brick, I was told, memorializes a soul born into slavery.

But I remembered too the accomplishments of the British actress Fanny Kemble Butler, wife of the master of this famous plantation. Her *Journal of a Residence on a Georgian Plantation in 1838-1839* strengthened antislavery sentiment in the North and, some feel, was a factor in the British decision to refrain from aiding the Confederate cause. God works in mysterious ways.

On one island, at least, God seems to have ordained contentment. On the landing at

Sapelo Island I met Tracey Walker, pilot of the ferryboat *Sapelo Queen*. He painted an idyllic picture of his island. "We have 75 or 80 black families all the time," said Tracey. "During the weekend, when my business is at its best, maybe 200 people will come home to the island. Many of them work in Brunswick, St. Simons, or Savannah. People from Sapelo are living all over the world. But they always come home. We have an equal number of men and women, so there is someone for everyone. There are seldom any divorces and never an orphan because every child is welcome. If a person starves on Sapelo, something is definitely wrong. My grandmother Mrs. Annie Walker, who is 95, was born in Sapelo and can still walk around."

"Does Sapelo have *any* problems?" I asked. Tracey gave me a jaunty smile. "We have no drugs, crime, or jail," he replied, "and if we did have a drug problem, there is only one way to go, and that is to the boat."

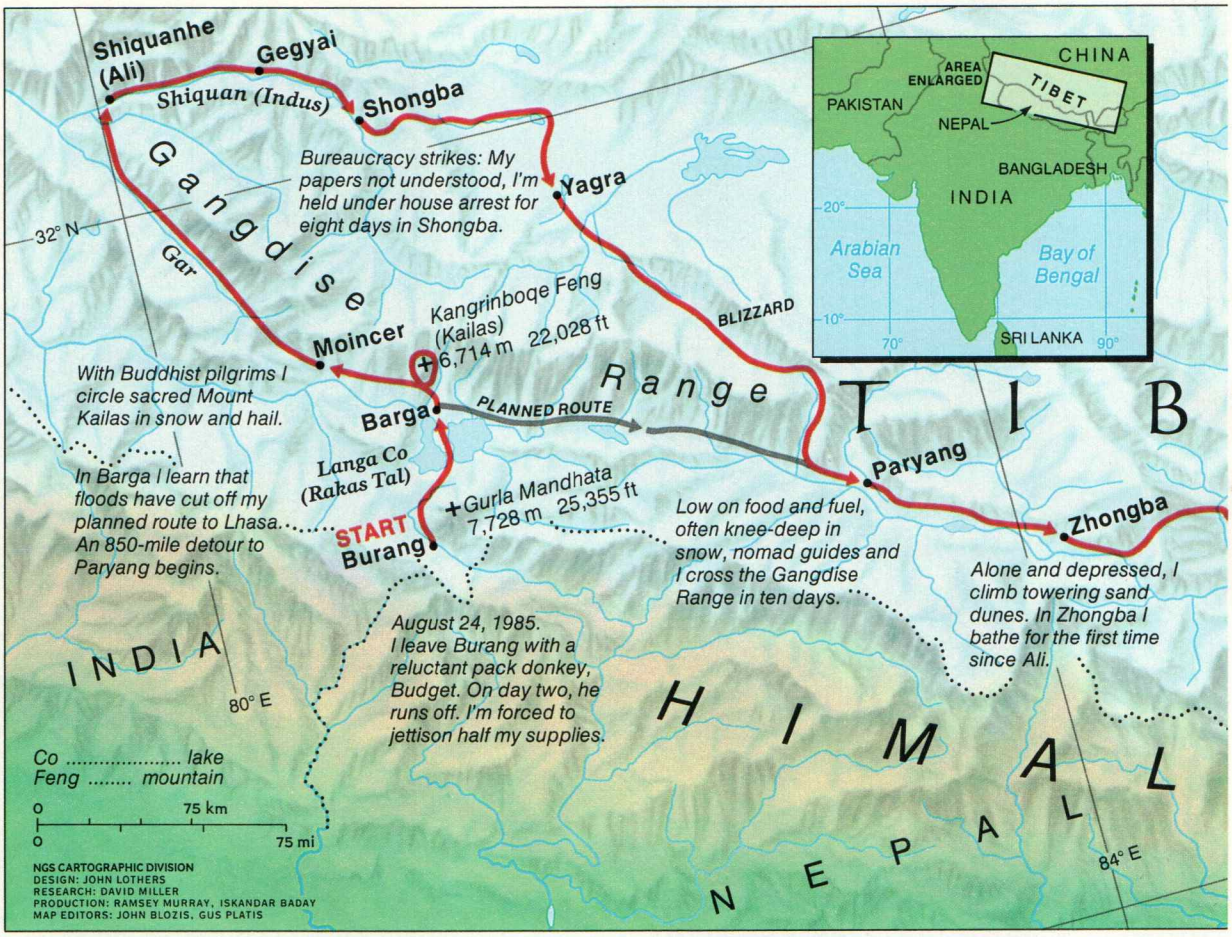
I had been told that they used to have hags on Sapelo—supernatural visitors who terrorize people at night while they sleep—but everyone on the island assured me that the hags have gone away because nobody believes in them any longer. □

Nomads' Land

A Journey Through Tibet

I was snow-blind for 36 agonizing hours midway through my 1,800-mile trek across Tibet. When I regained my vision in a nomad's tent in the Gangdise Range, these children were my first sight. Their smiles encouraged me to go on.

ARTICLE AND PHOTOGRAPHS BY SORREL WILBY



SEPTEMBER 11, 1985:

I have to keep walking. To stop means to freeze, to die. The sun has set and taken all warmth from the earth with it. The burning sensation on the tips of my ears, the numb needling pain in my toes tell me the temperature is well below zero. MOVE, Sorrel—WALK!

On and on. . . . The god of night wraps me in sequined black velvet, a sky cloak of diamonds. I am too cold to appreciate the resplendence of these stars, too delirious to comprehend the speed with which so many shatter—and fall. Cardboard cutout mountains surround me. I am alone.

To trek across Tibet had been a dream. Now it has become a nightmare, complete with apparitions, voices, tormenting me with thoughts of eternity. To combat fear, I talk continuously to my camera. I must not stop moving; I have no shelter, no source of heat except movement. Distant lights lure me beyond the limits of conscious will. Shivering, I stagger toward them, through a marketplace and up to a single lighted window. I pound my fists on a heavy wooden door. Let me in, please let me in! The door opens. I have walked 40 miles in 23 hours. Exhaustion melts and falls as tears. It's all right, I'm safe.

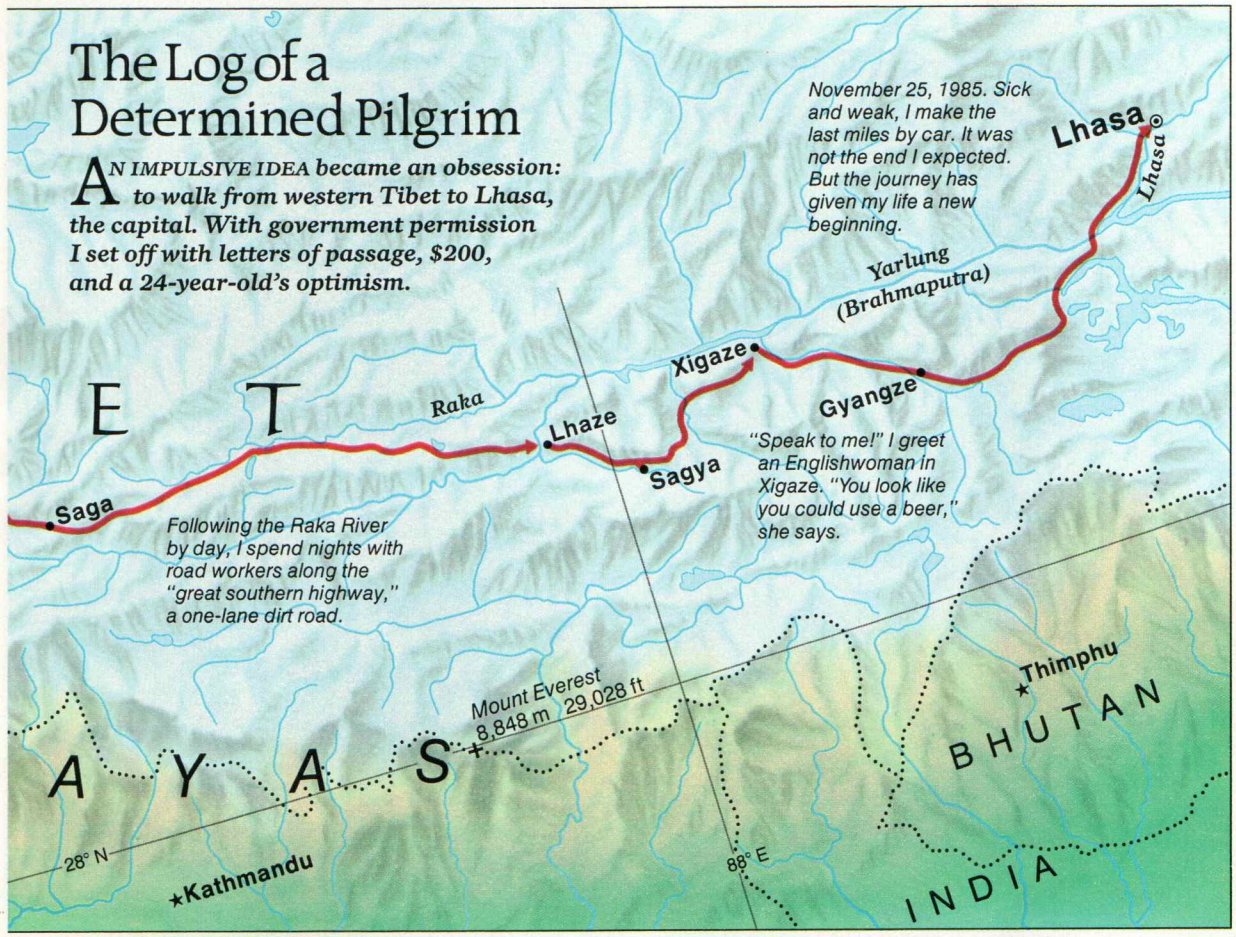
THUS MY DIARY records my arrival in Ali, a city on the western edge of Tibet's northern plateau, the Chang Thang. At that point I was three weeks and 300 miles into my journey across Tibet, which had begun at the town of Burang near the Nepalese border. My goal was Lhasa, Tibet's capital, a 1,500-mile trek to the east.

I had miscalculated badly on the stretch just before Ali, venturing into an uninhabited region and allowing myself to be caught at sundown with many miles still to go to the nearest shelter. I was lucky to have reached Ali—and to be alive.

I was not a total stranger to Tibet. The year before, I had visited this long-forbidden land as part of a 10,000-mile solo bike ride across Asia. The trip had been a

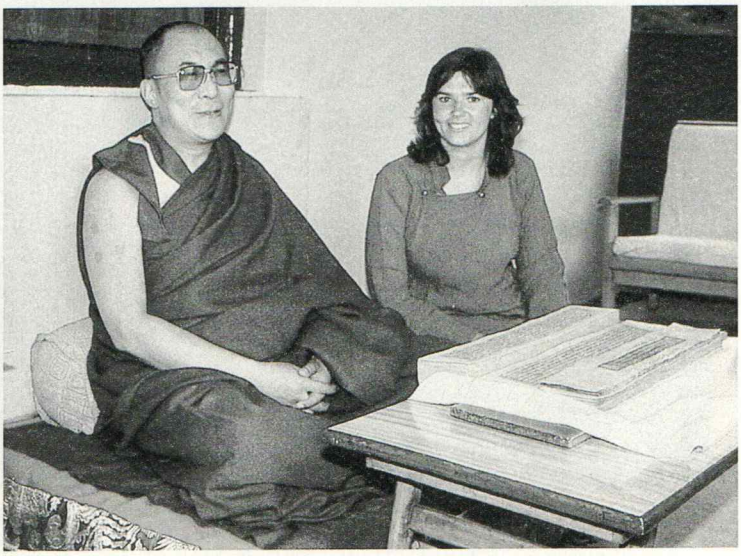
The Log of a Determined Pilgrim

AN IMPULSIVE IDEA became an obsession: to walk from western Tibet to Lhasa, the capital. With government permission I set off with letters of passage, $200, and a 24-year-old's optimism.


November 25, 1985. Sick and weak, I make the last miles by car. It was not the end I expected. But the journey has given my life a new beginning.
Lhasa
Lhasa
Yarlung (Brahmaputra)
Xigaze
Gyangze
Raka
Lhaze
Sagya
"Speak to me!" I greet an Englishwoman in Xigaze. "You look like you could use a beer," she says.
Saga
Following the Raka River by day, I spend nights with road workers along the "great southern highway," a one-lane dirt road.
E T
Mount Everest 8,848 m 29,028 ft
A Y A S
Thimphu
BHUTAN
28° N
Kathmandu
88° E
INDIA

FOR AUTHOR Sorrel Wilby the Dalai Lama was a gentle man who gave her a blessing and a pinch on the cheek before she began her Tibetan trek. For millions of Tibetan Buddhists he is the 14th reincarnation of their patron god. To the People's Republic of China he is a leader-in-exile of forces trying to drive out the Chinese and reestablish Tibet's independence.

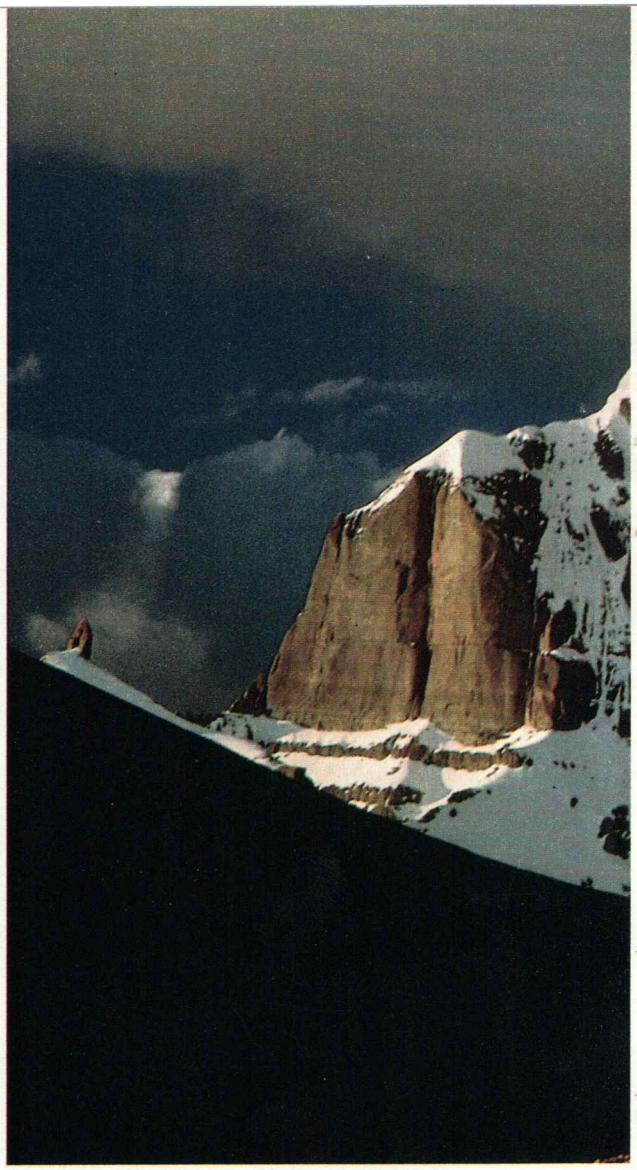
Tibet has been part of China since it sent troops into the country on October 7, 1950, citing precedence for rule of Tibet since the seventh century. The Dalai Lama fled to India following an unsuccessful 1959 revolt against Chinese rule. As the 37th anniversary of the Chinese occupation approached this past fall, the Dalai Lama came to the United States, prompting an official complaint by the Chinese government.



On September 21 he spoke to members of the U. S. House of Representatives about human-rights violations in Tibet and urged declaration of the country as a demilitarized zone of "peace and nonviolence." Six days later a demonstration by Buddhist monks in Lhasa led to Tibet's most violent protests since 1959.

—THE EDITOR

AT THE FOOT OF MOUNT KAILAS, a spiritual center to Buddhists and Hindus (right), a pilgrim lifts praise to Buddha before an altar of prayer flags (below). To circle Kailas is a sacred pilgrimage; some make it on their knees (facing page). A nun took me under her wing for the two-day, 30-mile walk.



learning exercise toward a career in travel writing and photography. It was certainly an unorthodox way of going about it, but nothing—absolutely nothing—was more repugnant to me than the thought of continuing my formal education in my homeland of Australia.

That brief glimpse of Tibet determined my next project: I would travel across the country alone and on foot. The idea would have remained a dream without the help of Jigme Surkhang of the Sports Service Company of Tibet, a quasi-governmental organization in charge of visits by foreign athletes and expeditions.

A book by the author, *Journey Across Tibet,* will be published next spring by Contemporary Books, Inc., of New York City.

Jigme was above all practical. He regarded my idea of simply buying a yak and setting off across Tibet as utterly suicidal. During our meeting in Lhasa in the fall of 1984 it was agreed that I would return the following year and that I would abandon the idea of a yak in favor of a more prosaic but manageable donkey.

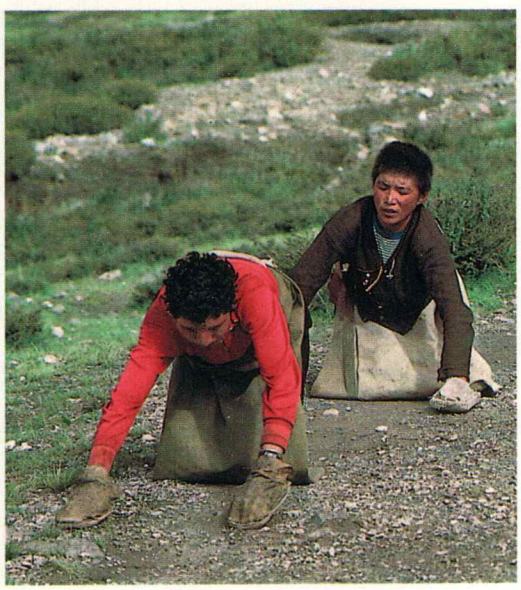
Although Jigme never mentioned it, I believe he arranged for word to be passed among Tibetan nomads in the areas I would visit to help me on my way.

That winter other people pitched in to help. Dick Smith, publisher of the newly founded *Australian Geographic* magazine, provided a round-trip ticket from Sydney to Kathmandu. I went by way of India for a mountain-climbing course and by sheer luck met the Dalai Lama, Tibet's revered

ALL BY HUGH SWIFT

religious leader in exile, at the mountain town of Manali. The Dalai Lama gave me his blessing and some 200 small portraits of himself to give to Tibetans along my route.

On August 24 I left the village of Burang on the Nepal border with camping gear, food, $200 in Chinese yuan, and a newly purchased donkey I had named Budget.



A GLORIOUS SUNRISE spilled over the turrets of fortress-like mountains enclosing the valley north of Burang, beckoning me with a sense of excitement. By contrast, Budget suffered from a severe case of ill-temper, and he marked our first day on the road with a lot of resentful balking and hee-hawing.

By the next evening my $80 donkey had had enough—enough of my incompetence

GOAT-MILKING LESSONS followed dinner in a nomad camp near Moincer (left). My city roots showed, but it was a way to thank my hostess, Tsomo, for filling me with yak milk, goat cheese, barley porridge, and percha—tea churned with rancid yak butter. That night her children gave me a giggling lesson in western Tibetan dialect by pointing to parts of their bodies. Weeks down the road, with an expanded vocabulary, I shared tales with old Dordrum (above) and his wife. Nomad men sleep under sheepskins outside the family tent, even in the chilling gales of the northern plateau.

and constant kick starts. I had just unloaded Budget and bathed in the icy waters of Rakas Tal, a lake 36 miles north of Burang. I was suddenly stunned by the vision of a pink-and-gold sunset tickling the 25,355-foot peak known as Gurla Mandhata.

I dropped Budget's lead rope and dived for my camera. After several frames I noticed a splendid donkey through the view finder. A splendid *fast* donkey, tearing across the plains toward the mountain. Oh, how I wished my donkey could move that quickly! I focused in on the wonder-ass—and dropped my camera. It was *my* donkey! A moment later his gaunt black body was swallowed by the shadow of Gurla Mandhata. I never laid hands on him again.

After a futile, barefooted attempt to catch my jet-propelled Pegasus, I began to sort through my 130 pounds of supplies.

Into a single pack I crammed tent, sleeping bag, down jacket, cooking equipment and stove fuel, two water containers, writing material, 30 packets of dried soup mix, milk powder, coffee, two dozen dried fruit-and-nut bars, Band-Aids, a toothbrush, chewing gum, and one precious bar of Toblerone chocolate. I ditched the rest, reducing the weight of my load by half.

Since my feet were now a mass of small cuts and bruises, I carefully bandaged them before donning my new, and as yet unbroken, heavy-duty climbing boots. I tossed my soft-soled sneakers onto the pile of discarded paraphernalia, and within six miles I added blisters to my growing list of woes.

AT THE MUD HAMLET of Barga I got an unwelcome surprise: My intended route due east to Lhasa had been cut by floods. My only option was to go northwest through Ali (Shiquanhe in Chinese Pinyin), then proceed eastward through Gegyai, Shongba, and Yagra, and finally cross the great snow-capped Gangdise Range to rejoin the route to Lhasa at Paryang. All this meant a "detour" of about 850 miles, and I took the rest of the day off to recuperate from the shock.

At Barga's no-star, one-story hotel I met some pilgrims returning from the holy peak, Kailas. They offered me some Tibetan tea, and I managed to drink three cups of the traditional beverage. Tibetan tea is made with salt and yak butter, and it isn't the easiest drink to get used to. But it was time I started liking it. In order to understand Tibetans, I had to try behaving like one and, if possible, even attempt to sound like one. I fumbled through my pack and found *Tibetan for Beginners and Travellers,* a book by one of the great authorities on Tibet, Dr. Melvyn Goldstein. He had compiled it with the average tourist in mind, but my circumstances were slightly different.

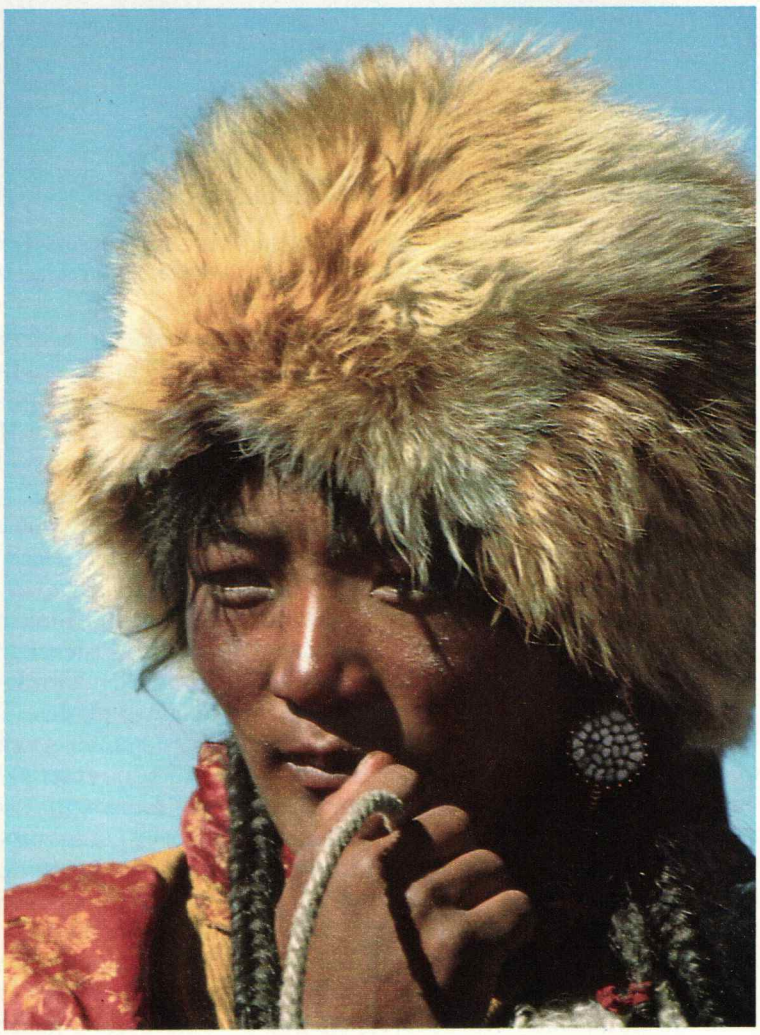
"Chu tsha-bo du-gay?—Is there any hot water?" I began. That raised a few eyebrows. *"Ngay kang-miy-giy di-miy ka-ba to?*—Where is the key to my room?" That wasn't too helpful—my "room" didn't even have a door on it! *"San-ju ka-ba to?"* Someone pointed to the plains behind me and laughed. The whole world is a toilet. Go anywhere your heart desires! At that, for the first time since leaving Burang, I laughed with my new friends until my tummy ached—the infectious, joyous laughter of

the Tibetans I was learning to emulate.

Leaving Barga, I joined throngs of Indian and Tibetan pilgrims, monks, nomads, and their flocks of sheep, yaks, and horses, all circumambulating Mount Kailas (Kangrinboqe Feng), revered by Buddhists and Hindus alike.

My companions on the trek seemed dumbfounded at my presence—a Westerner, apparently walking all the way from Mount Kailas to Lhasa. God knows what evils they thought I had committed to require this ultimate penance. With a mixture of sign language and a small but growing Tibetan vocabulary, I managed to communicate with my fellow pilgrims. Some asked about my family, my crops, my sheep—who would tend them while I struggled to attain spiritual purification? To avoid explanation, I simply replied by chanting the devotional phrase, *"Om Mani Padme Hum* —Hail to the Jewel in the Lotus."

By the time I had completed the circuit of Mount Kailas, I was so weary and worn that the phrase had transformed itself in my mind to "Oh-mummy-take-me-home, Oh-mummy-take-me-home." The phrase was to gain added appeal a week later when I was attacked by three guard dogs at a small military outpost northwest of Moincer. Their energetic greeting left me with gaping wounds on my right leg, heel, and arm. A military doctor in the compound stitched me up after plying me with swigs of Chinese firewater in lieu of anesthetic. The treatment failed to ease the pain, however, and my screams echoed through the compound. But I felt even worse the next morning: In addition to the pain from my wounds, I had a massive hangover.



FOX FUR and turquoise dress a horseman awaiting a race in Yagra (right). I arrived at the start of a three-day, hard-racing, hard-drinking festival. On horses wearing bright tack (left) embroidered by the men, riders galloped tightly around us like an out-of-control merry-go-round, then thundered across the plain. Basketball competition followed, and that night there was dancing—a slow and monotonous Tibetan shuffle. Later some young women took me home, turned up a tape of Chinese disco music, and said, "Dance! Teach us how to do it your way!" I stalled. Would I be aiding the destruction of their culture? Oh well, I bumped and jived with glee. The wheel of life revolves on and on.

NORBOR TRIED TO PLEAD INSANITY, but a jovial crowd in Yagra persuaded the nomad, center, to take me with his yak caravan into the snow-covered Gangdise

AT A HOTEL in the town of Moincer I was robbed, the only time during my entire trek. A young couple with a desperately ill baby stole my wallet, which contained my $200 emergency fund. They took it only to buy medicine for the child and were quickly apprehended. Through the paper-thin walls of the hotel I could hear the brutal interrogation and flogging suffered by the couple. When the money was later returned, my conscience ached terribly.

Hard luck struck again beyond Moincer, when I lost all my gear—pack, tent, sleeping bag, everything. Tired of the strain of a 65-pound pack, I put my belongings on a passing truck and asked the driver, a Tibetan named Tsering, to leave it at the next nomad camp, a day's trek ahead. Unfortunately, he didn't understand my beginner's Tibetan and took the pack all the way to Ali, a good five days' travel on foot.

It was at the end of those five days that I miscalculated badly and very nearly froze to death on the nightmare 40-mile hike to Ali.

Ali is an ugly place—a scar on the western cheek of Tibet. My second morning there I ventured into the streets. I shot a few baskets with some track-suited athletes on a basketball court and stood shivering with them later while the Chinese national anthem blared over Ali's loudspeaker system.

The morning broadcast stirred Ali into action. Truckers rose from their cabins near the river, cranking their bodies and the engines of their vehicles into life. Bleary-eyed public servants headed for drab offices. Mothers emerged from doorways leading children by the hand and inserting them into school-bound processions.

From the very start Tibetan children had been a delight. At a nomad camp a week before Ali, the kids had taught me anatomy, touching and then naming their ears, eyes, bottoms, and belly buttons. Earlier there had been a goat-milking session, the first

Range. It was a four-day trip to Paryang, Norbor told me at the start. When he turned back a week later, his unwavering estimate was still four days.

half of which I spent trying to locate the second set of teats on my goat's udder. No one had told me goats were different from cows. I was learning.

I finally located the truck driver with my belongings. Retrieving my Swiss army knife from the pack, I removed the stitches from the dog bites in my leg and arm. Then I smiled farewell to Ali.

THERE was a hint of early winter in the air; it was September 14, and I was headed for Shongba, about a hundred miles away up the Shiquan River Valley.

As the valley, and I, grew comparatively narrower, the mountains on either side assumed characteristics of remembered foods from home. Honeycomb-weathered cliffs waited to be dipped in the chocolate shade of afternoon. A bend in one rock wall became a row of exotic artichoke hearts. On the left side of the river, Turkish-delight-colored hills glistened temptingly in the sunlight. Behind them, dark mountains of Christmas pudding lightly dusted with sugar icing completed my imaginary banquet. I stopped frequently to slake my thirst at the bubbling river . . . ahhh, champagne!

Yet disaster never lay more than a breath away. Walking one afternoon along the base of a towering red cliff, I noticed the rubble beneath my feet. It was fresh and loose. I realized the blasting sounds I had heard earlier in the day had probably carried downwind from this very spot. What if. . . .

Just then I rounded a turn in the cliff and faced scores of Chinese and Tibetan road workers swarming like ants across the slope. Shovels dropped and mouths fell open as they stared at me in horror. Then suddenly *Kaboom! Kaboom! Kaboom!* Behind and above me the sheer cliff fell away, burying my fresh footprints in landslides of debris. The blast knocked me flat on the ground. I picked myself up, dusted myself down, and

kept on walking, hoping the men couldn't see the terrible trembling in my legs.

At Gegyai the town headman, or *goti,* gave me permits and letters to other goti ahead, asking them to help me on my way. The letters hinted at guides and pack animals, and I was as happy as a yak in snow.

At the five-house "town" of Shongba I learned that the goti was away, and his deputy—unable to read my permits and passes—clamped me under house arrest. I was so depressed that I ate my bar of Toblerone.

Freedom finally came after eight long days. The goti returned and apologized, then introduced me to Yarbo, a guide who was destined to become one of my dashing knights in fur armor. With snow fast on our heels, Yarbo and I crossed the edge of a dry salt pan and headed east toward central Tibet, the most challenging phase of my journey. Here was an area totally devoid of foot roads or trails for hundreds of miles.

Along with the challenge came beauty. Before long we reached a river. A hundred wild Tibetan asses were standing on the far bank. The reflection of the sun on the water dappled their underbellies. They were the links of a golden chain, suspended beneath the breasts of mountains. As Yarbo and I approached, the chain fragmented. The links suddenly went wild and danced away, disappearing between folds of soft velvet pasture.

After some days Yarbo turned back, entrusting me to another volunteer guide, who in turn passed me to another, and so on. The journey was a blend of fatigue and fascination. Finally I reached Yagra, the last village before the forbidding Gangdise Range, the great snow-clad barrier across the route to Paryang.

My arrival in Yagra was timely. Nomads from all directions had ridden or walked to the isolated village for the yearly regional horse-racing festival. Nomad riders on deceptively scraggly mounts competed for three days, drank for three days, danced and laughed for three days. Nearly always they welcomed my involvement.

But some activities, such as gambling, seemed strictly for men. I found that out the hard way. Ever curious, I stumbled into a large tent pitched on the outskirts of the village. I stepped forward to introduce myself to the circle of men hunched in one corner over a mah-jongg board. Empty Chinese liquor bottles lay on the ground. Cigarette butts. Money. And no women in sight.

Suddenly a Khampa, one of the huge tribesmen of eastern Tibet, rose from the circle and drew his sword, his face tense with anger. His lips parted in a chilling scream that jolted me into action. I turned, ran—and tripped on the dirt floor of the tent.

In an instant the Khampa's sword swept down, seemingly aimed directly at my throat. The blade sliced the air and came to rest an inch from my jugular vein. It all happened in a split second, but it seemed an

Tucked in a sheepskin cocoon, a nomad girl sleeps beside dried yak meat. I never heard a nomad child cry. Wrapped in extended families, they receive constant attention and love. A kiss for grandmother returns her affection (facing page). I felt it too. Tibetans know the beauty of giving; they share whatever they have.

eternity before the Khampa's companions came to their senses and pulled him away. I lay on the ground a while longer, stiff as a corpse with fear.

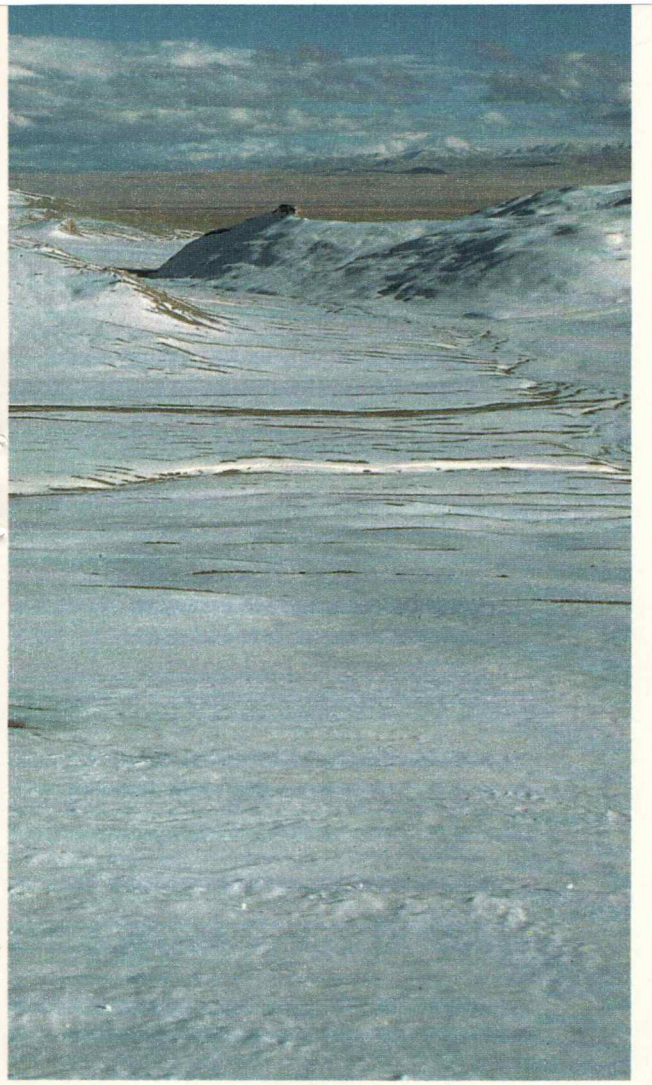
Friends who have spent many years in Tibet later insisted that the Khampa was only trying to frighten me, not kill me. If I had died, they pointed out, the Chinese probably would have hunted him down and executed him outright. But I saw the look of hatred in the man's drunken face, and whatever his intention may have been, he came within an inch of killing me.

By contrast to the episode at Yagra, Tibetans everywhere did all they could to help me. They have to be the most generous people on earth. Whatever they have, they will share. It doesn't matter who you are; it doesn't even matter if they have next to nothing. Half of next to nothing isn't very much, but it's yours.

AFTER THE FESTIVAL at Yagra a sad-eyed, bulbous-nosed old nomad named Norbor reluctantly agreed to guide me as far as his camp in the foothills of the Gangdise Range. Sporting a well-worn sheepskin bonnet, a *chuba,* or jacket, lined on the outside with black corduroy, and knee-high felt boots, Norbor looked exactly like a performing bear from a Moscow circus. I adored him instantly.

As we approached the Gangdise Range, light snowfalls became blizzards, food and fuel dwindled, and putting one foot in front of the other was a constant effort.

Beyond Yagra, Norbor and I joined up with other nomads journeying eastward, and as we neared the high country, we numbered six men, 17 horses, 24 yaks, one woman, and a dog. One afternoon I watched in awe as my companions negotiated a deep, fast-flowing river. Each man simply leapt



EUPHORIA REPLACED EVERY PAIN as guides Gyardup and Chumba and I neared the dry brown plains of southern Tibet. After ten harrowing days in the Gangdise Range my face was a mask of bloody sores cut by blizzards; three fingers had been mangled in a fall from a horse. Even now our direction was uncertain—we had burned my map for fuel.

astride a yak as the animal started across and was thus ferried to the opposite bank without a splash of water on his clothing.

I took a running leap at the last beast in line—and scored a clean miss. My friends collapsed in laughter on the other bank, but I failed to find my situation amusing. I stripped off my soaked shoes, socks, overalls, and long johns, and wobbled, petrified, through the river, instinctively choosing the deepest section.

Our party suddenly dwindled. Norbor finally turned back for home, and two of our nomads camped by the river that we had just crossed. The other three—Namgyal, Garma, and Lobsang—and I hit the snow line at 12,000 feet with a dozen yaks. We started climbing.

It was physically exhausting to walk and breathe at the same time. At 18,000 feet I was beginning to think Sir Edmund Hillary was nothing short of a god. It took me four hours to reach the top of the 19,500-foot pass. The others were already there and lay as still as dirty laundry strewn across the carpet of snow, gazing into unrelieved whiteness.

I couldn't believe my eyes. Instead of a downward slope leading toward Paryang, there was simply more snow. The top of the pass was nothing more than a white crater encircled by broader snow plains, and still higher peaks.

My heart sank. The sun sank. Unperturbed, the yaks stood calmly—as solid and proud as stone Mycenaean gate lions.

For the next three days we walked blindly through a relentless blizzard. The skin on my cheeks blistered, froze, and cracked open. My eyes were bloodshot from the needling snowflakes, and my lip split in several places from windburn. On the third day we came to the remnants of a recently abandoned fireplace. Hope! Salvation! We must be nearing civilization. Garma bent down in the ashes and sifted out a strip of gymshoe fabric. It was part of a boot he had repaired two days earlier. We had walked in a complete circle. We made camp that night in silence.

BRILLIANT SUNSHINE shocked me awake the next morning, and with it my companions found the correct route. Three hours later we were actually descending. Ahead and below lay an enormous valley, patchworked with snow and flocks of sheep. By nightfall we reached the shepherds' camp, and I bedded down in one of the tents.

The following night I awoke in a sweat. I couldn't see a thing, and my eyeballs were on fire. Snow blindness! Oh my God. I had tried to prevent it as my guides had by knotting my two short braids across the bridge

of my nose to reduce the sun's glare, but it hadn't worked.

The pain was excruciating. Suddenly I felt prickling sensations around my midsection. I touched the area, and the skin on my rib cage felt like a page of Braille. Great. Fantastic. *Fleas!* Fleas and snow blindness. I scratched and cried until the stirring sounds of my host family indicated the dawning of a new day.

Someone asked me what was wrong. *"Nga-rang mig min-du. Mig-chu mang-po mang-po*—I haven't got any eyes. Many, many tears," I answered.

Someone pressed a cup of hot tea into my hands. I took a sip and felt an errant sheep dropping floating on the surface. All the romance of being a Tibetan nomad suddenly vanished from my mind.

The tears fell in torrents down my cracked and bleeding cheeks. Putting up with runaway donkeys, blisters, dog bites, stitches, freezing nights, lonely days, dynamite blasts, sword-wielding madmen, blizzards, and frostbite was one thing. But fleas and snow blindness were the absolute end.

For 36 hours I suffered. And not, I regret, always in silence. Finally my sight began to return, though the fleas remained permanent companions.

THE SHEEPHERDERS took over from Garma, Namgyal, and Lobsang. I said good-bye to my three companions of the high mountains and set off with two of the herders toward Paryang.

After a day and a half, through strained, bloodshot eyes, I glimpsed the great southern valley route to Paryang. To this day the vista remains the most spectacular in my memory. I was alive—not quite at the end of my long journey, but over the worst of it.

Today what I most vividly recall of Paryang are the many Tibetans who helped me get there. They suffered with me every inch of the way, never a tear shed in anguish or reproach, never a word uttered in anger. Their hands were always outstretched to help me, but never for reward or payment of any kind. All I could do in return was honor their faith in me—go on, and reach the holy city of Lhasa.

I broke the last half of my journey into five sections: three days to the town of Zhongba; five more to Saga; seven or so from Saga to Lhaze; four or five days from Lhaze to Xigaze. From there Lhasa was only ten days away. The entire route lay along the southern roadway that winds across central Tibet.

A LITTLE WORK and a lot of play keep young boys entertained during the late October barley harvest on a commune near Lhaze. I was giddy too; I had just seen my first tree in months. It didn't have any leaves, but I wanted to hug it.

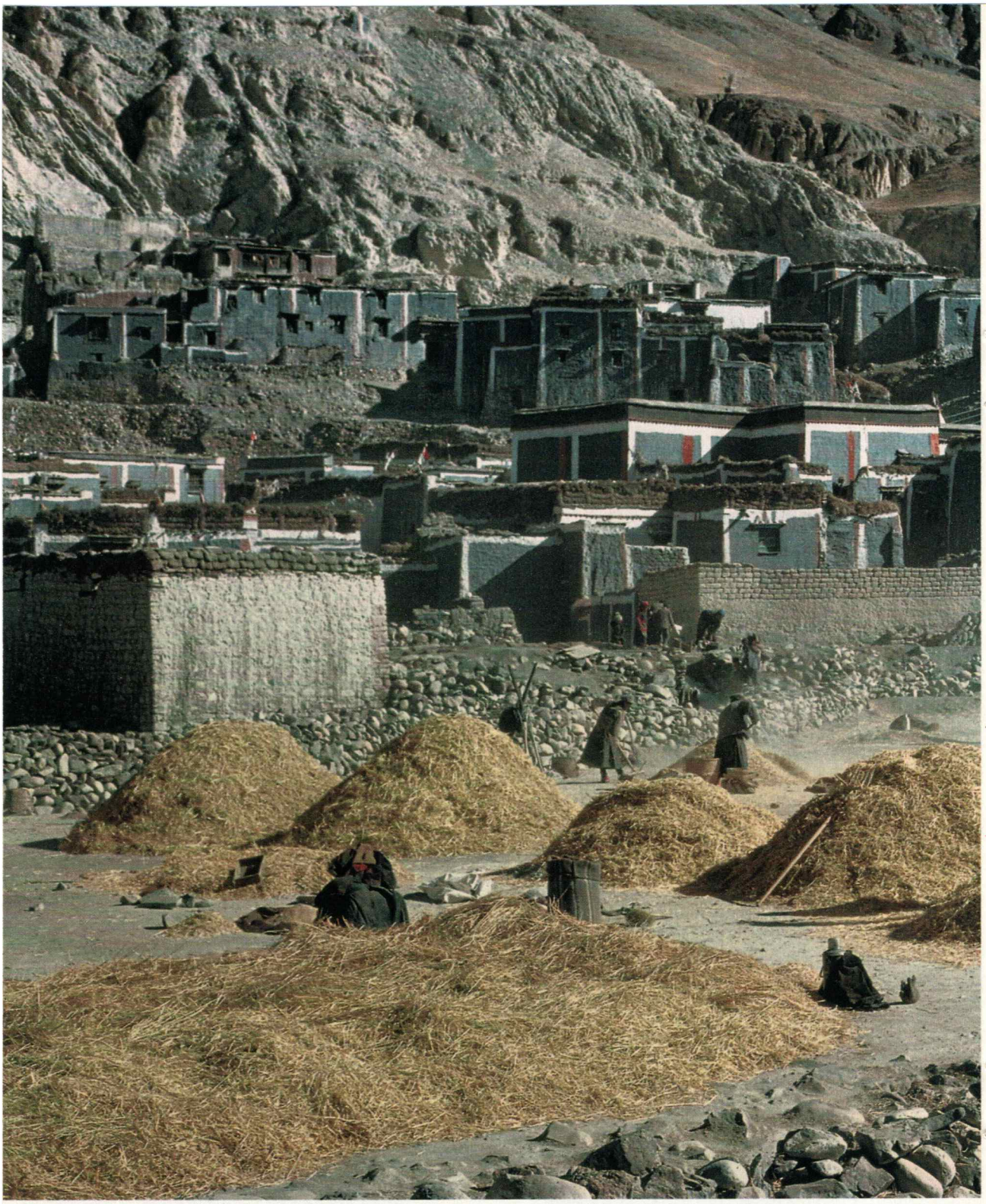
From Saga onward the unpaved road is meticulously maintained by an army of hospitable and rural—as distinct from nomadic—Tibetans with their antiquated machinery. A road grader in these parts is a long bar of metal pulled by a mule. Bulldozers are unheard of; the road gangs use spades.

JUST BEFORE the town of Lhaze I came to a lake and stopped for a time. The distant purple-tinged mountains and the white cotton-candy clouds floating above them were reflected in the lake's mirror-smooth surface. I strolled around a bend in the embankment and surprised several hundred water geese and ducks, bobbing up and down like floating lilies on the gentle ebb of the vast pond. As one, the birds took off in fright—a thunderous cloud of flapping wings, a cyclone of sound and energy. They circled a few feet above the lake, then landed again. The geese quacked and squawked to one another, readjusting their feathers in a noisy flutter as they glided effortlessly across the rippling water.

Suddenly I was in a large opulent room at a harborside cocktail party. Snippets of conversation echoed in the goslings' merry chatter. The faint chime of the wind sounded like champagne glasses endlessly touched in toasting. Water-bird feathers ruffled like the fur coats of rich widows. The silver flash of huge diamond rings caught my eye—sunlight fragmenting into a thousand jewels across the water's skin.

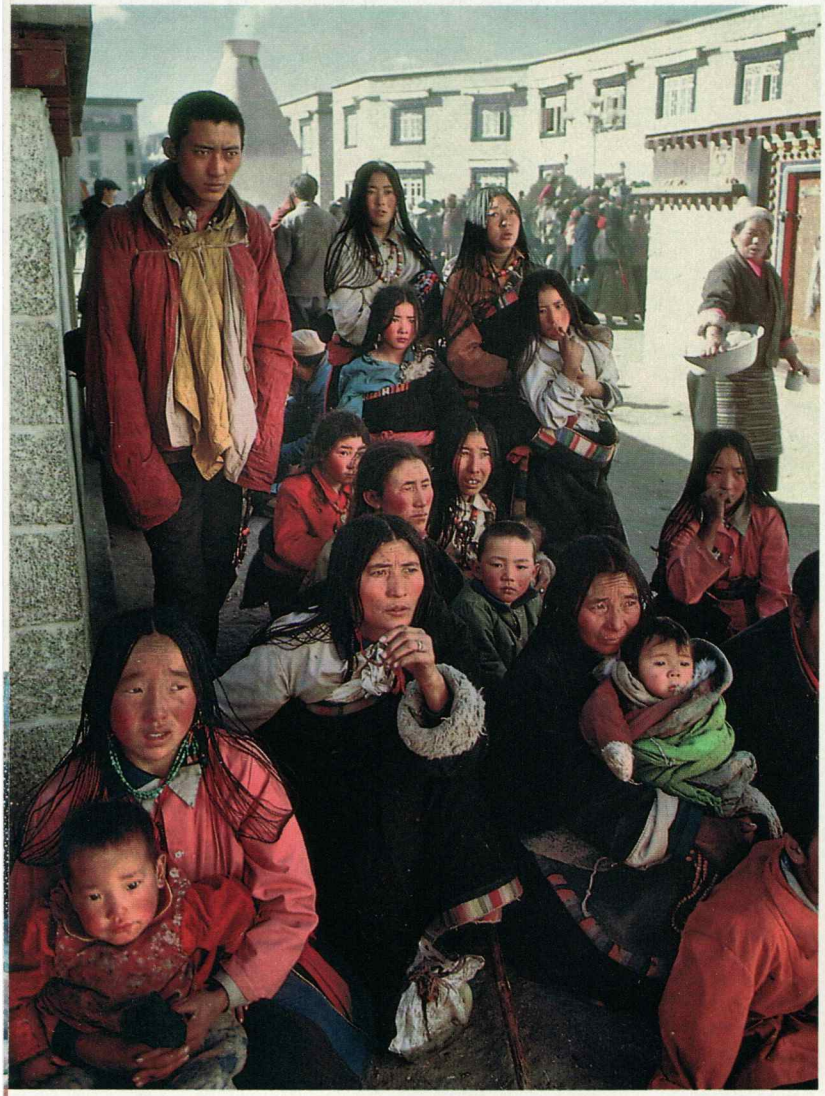
At that moment, I knew I loved Tibet more than anything in the whole universe.

It was a day for splendor, for rare and simple gifts. Just hours after leaving the lake, I reached a farming commune and stopped in my tracks. Before me there was a tree! It



HARMONIOUS VOICES wafted on a gentle morning breeze; farmers in Sagya were singing as they winnowed barley. Seeming to grow out of the mountain, their painted mud-brick houses copy designs from the Sagya Monastery. I was startled by a sign at the monastery gate: "No photographs inside. Three yuan entrance fee for foreigners." It was in English. Sagya was gearing up for tourists.

Tibet's increasing openness to foreigners began in 1980 with a series of government reforms. The Chinese began restoring monasteries and temples they had earlier destroyed and in 1982 lifted a ban on religious practices. My nomad guide Norbor had been jailed for 17 years for refusing to renounce Buddhism. When I gave him a photograph of the Dalai Lama, one of 200 I passed out, he wept.



SOLEMN PILGRIMS crowd the courtyard of Lhasa's Jokhang Temple (above), Tibet's holiest shrine. My own pilgrimage ends in front of the Potala—former palace of the Dalai Lama—with a new pair of shoes and a new love for the joys and the mysteries of life.

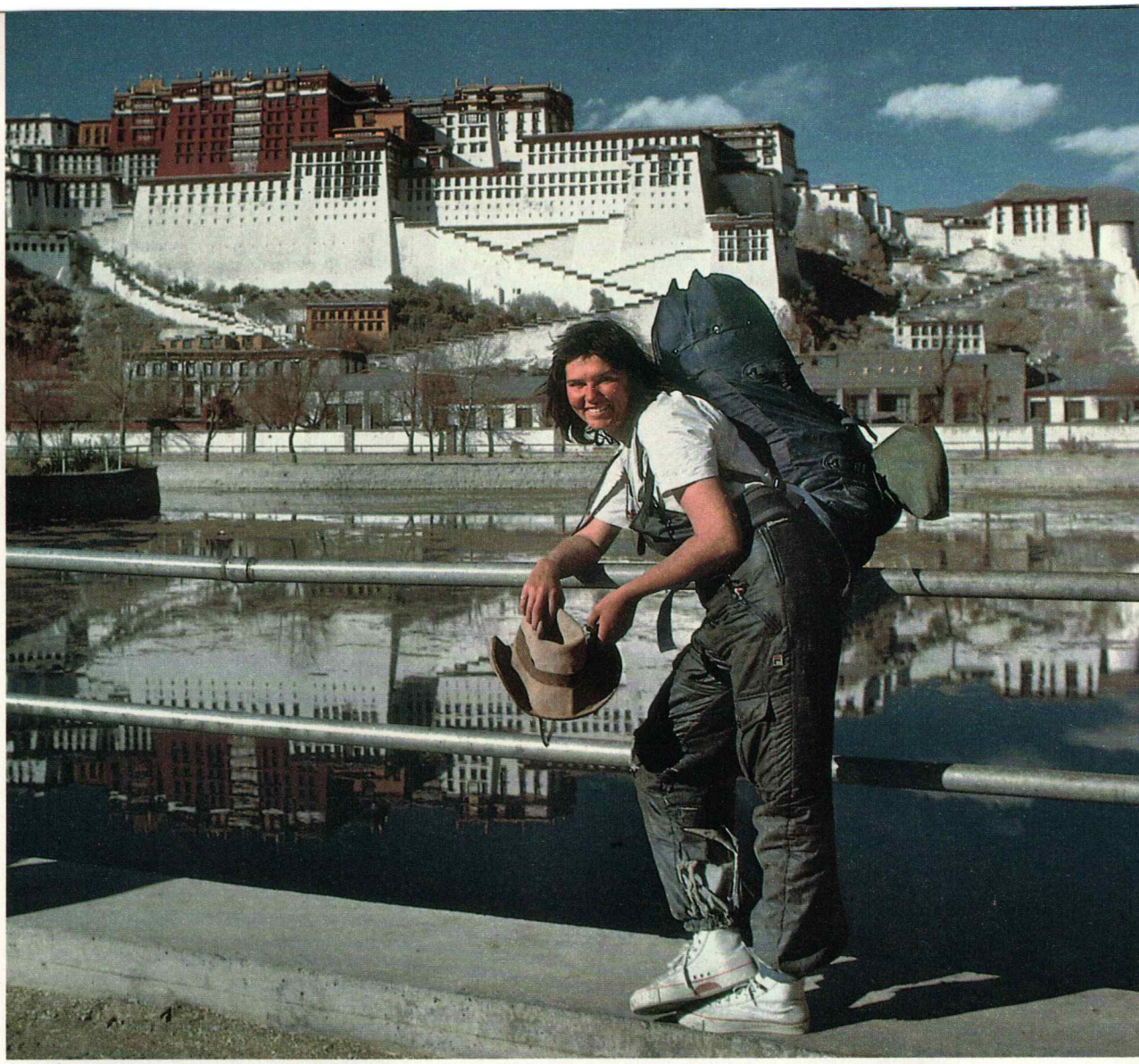
didn't have any leaves on it, but it was still a tree, the first I had seen in months.

Outside the town of Lhaze a white jeep pulled up alongside me. The driver, a Tibetan, offered me a ride. I hesitated. I hadn't been in a vehicle for months and I was walking—remember?—every inch of the way, like a pilgrim.

The driver mentioned that there was a hot spring just four miles ahead on his route. I threw my backpack into the rear of the car and jumped in. Who was I trying to impress? Boy! A lake, a tree, and now a bath—all my Christmases had come at once.

And at last there was Xigaze. My spirit soared. Ten days remained, ten days of easy walking, and mostly downhill at that. Xigaze was full to the brim with pilgrims. I avoided the crowds and danced off to find the branch office of Jigme's organization, the Tibet Sports Service Company. I wanted more than anything in the world to phone Jigme in Lhasa, to tell him of my adventures, and to thank him: I'm alive, Jigme, safe, and Lhasa-bound—get the champagne ready!

But at the Xigaze branch office my request was met with shocked silence,



followed by a polite explanation: I couldn't phone Jigme. Jigme was dead. He had been killed in a car accident while driving to the Lhasa Airport to welcome a party of Everest climbers. Devastated, I started for Lhasa in a daze.

ON NOVEMBER 25 I reached the holy city—three months and 1,800 miles behind me. It was not the same without Jigme.

Alone in a cheap hotel dormitory I stripped off to bathe and looked down in horror at my naked body. Half of it was missing! Every inch of Tibet had taken something from me, every mile, every virus. Every flea had had its share of me, and hunger had done its worst.

A single tear fell from my eye. It was not for pride, not for myself. I suddenly realized the magnitude of what I had gained, not lost, on my journey through Tibet.

There had been days I remembered as gifts, but now I realized my whole life was a gift, a parcel to be held and unwrapped layer by layer. It had passed from the hands of one Tibetan to another so gently that I had not noticed them peeling away veneers of ego, pride, and ambition.

Tibet had unwrapped me, laid me bare. Not taken, but given—given me everything. Showed me a power I had long considered imaginary. A power called love.

In a week I would leave Tibet, but Tibet would never leave me. Its mountains and people were in my heart now forever. □

bed with his belt for protection. While asleep, he would often untie it to participate in such dream adventures as breaking the neck of a wounded deer—only to wake up to find his frightened wife in the crook of his arm. But like all the others, Abel found relief from torment with clonazepam, a drug that suppresses the violent behavior.

Though the reason for the malady, and why it afflicts older men primarily, is still unknown, the Hennepin team has shown the way to relief for sufferers in Minnesota and in other areas where the disorder is being diagnosed. In doing so, they join the ranks of a small army of dedicated researchers who are achieving new insights into one of our species' most ancient rituals, our nightly rendezvous with sleep.

They are saying amazing things:

• We are abusing sleep: Studies of body rhythms pinpoint shift work and long working hours as villains that cause diminished performance, nagging ailments, and sleeping on the job. Sleep abuse may be the hidden trigger of industrial accidents that occur with suspicious frequency at night.

• Clocks deep in our brains sound taps and reveille and also conduct the daily orchestra of our bodily rhythms. Staring at bright lights resets the hands of our clocks and may help the elderly sleep better as well as ease the wrenching effects of jet lag and shift work.

• There is a mysterious kinship between sleep and mental illness. Sleep deprivation eases depression, but it can also spur mania. Researchers are trying to find out why.

• Sudden infant death syndrome (SIDS), an ailment of unknown cause that nearly always strikes during sleep, remains one of the major killers of infants.

ELECTRONIC SENTRIES guard against sudden infant death syndrome (SIDS), a mysterious phenomenon that strikes mostly during sleep. In the United States SIDS is the leading cause of death from one month to one year of age. Electrodes beneath the pajamas of a seven-month-old (above) whose brother died of SIDS lead to a home monitor that detects abnormalities in pulse or respiration. At Massachusetts General Hospital in Boston, a host of functions are tracked on an infant victim (opposite) of severe apnea, the intermittent cessation of breathing.

• The most frequent patrons of our sleep clinics are those who sleep too much.

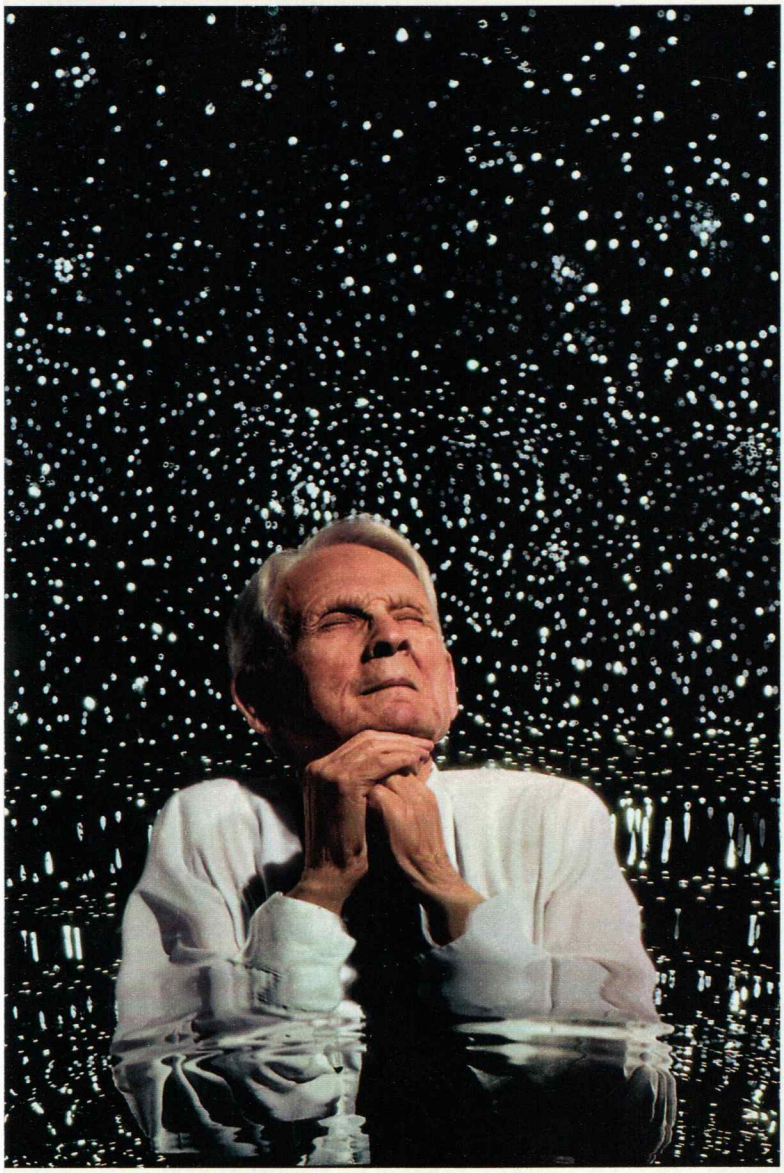
• Dreams: (1) reveal our hidden thoughts and tensions? (2) manifest the random firings of neurons? (3) clear our brains of useless material? Each theory claims adherents.

• A California psychologist says he intervenes in his dreams to make them end the way he wants.

• When you are yearning for your morning or afternoon tea, coffee, or exercise, you might be better off taking a brief nap.

• How long we sleep appears to be related to how long we will live, as well as to incidence of heart disease. Between 7 and 7.9 hours of slumber correlates with best longevity. Short sleepers have more angina pectoris, or heart pains; long sleepers more myocardial infarctions, or heart attacks. This does not mean that sleep of itself causes these conditions. Nevertheless, death, particularly sudden death, prowls the early morning hours.

Can we change our sleep habits? Veteran sleep researcher Dr. Wilse B. Webb of the University of Florida answers: "I spent five



EXPLORING THE COSMOS of sleep, Nathaniel Kleitman pursued the subject when others dismissed it as having no scientific interest. As a professor of physiology at the University of Chicago, Kleitman directed the work of graduate student Eugene Aserinsky, who discovered rapid eye movement, or REM, sleep in 1951. The finding proved that the brain is active during sleep and gave direction to modern sleep research.

A series of sleep wheels (opposite) shows the varying proportions of REM sleep (dark blue) and non-REM sleep (light blue) from infancy to old age. Newborns may spend as much as 50 percent of their sleep budgets in REM, leading to a theory that REM facilitates the development of neural networks.

years of my life trying to prevent nocturnal rats from sleeping during the day, and they spent five years teaching me I was rather foolish. There is a deep, inherent system here, and we cannot change it." Though human subjects can alter their sleep temporarily, they return to a sleep budget that seems genetically fixed.

AFTER the common cold, difficulty with sleeping is perhaps our most prevalent health complaint, ranging from transient insomnia to intrusive narcolepsy, which ambushes its victims with sudden and inappropriate slumber. Even a partial list of the more than 50 sleep disorders reads like a recipe for dread: head banging, sleep paralysis and sleepwalking, nightmares and night terrors, bruxism (teeth grinding), sleep myoclonus (kicking legs), and sleep apnea and other breathing disorders, including the often fatal Ondine's curse, named for a water nymph whose mortal lover was prevented by a jealous god from breathing automatically.

Mysterious and unexplained like SIDS, another sleep-related killer stalks Southeast Asian men wherever they live. A fibrillating heart and moans generally precede the sudden nocturnal deaths. One hundred fourteen men (and one woman) have succumbed in the United States in the past ten years.

Standing by to ease the troubled sleep of an estimated hundred million Americans, at least 170 sleep clinics operate in the United States. If you visit one, plan to sleep over, for many of the disorders of the night reveal themselves only then. Treatments range from drugs to sleep-style changes to surgery, but do not expect your doctor to answer one question: Why we sleep. Though theories abound, that remains an enduring mystery.

Indeed, until the early 1950s, those

scientists who thought about sleep at all were likely to agree with the renowned Russian physiologist Ivan Pavlov, who held that the brain sort of tuned down during sleep. Then Dr. Nathaniel Kleitman, a professor of physiology at the University of Chicago and the father of modern sleep research, asked Eugene Aserinsky, a graduate student, to investigate the relationship between eye movements and sleep.

As a first subject, Aserinsky installed his eight-year-old son, Armond, in a room borrowed from the physiology department, then hooked him up to an antique brain-wave recording machine rescued from the basement. Electrodes taped near Armond's eyes transmitted their movements to the machine, which reposed on a table beneath "a terrible light"—as Aserinsky will never forget—"in the shape of a gargoyle with a horrific face and bright eyes."

For two years Aserinsky made his painstaking observations. "The twitchings had been noted before," he says, "but nobody stayed up all night and recorded them objectively. Armond's eyes moved as if he was looking around, as if he was awake." What really surprised Aserinsky was regularity. "Suddenly there were movements; they would disappear for a time, then reappear."

The discovery swept aside Pavlov's theory by demonstrating forevermore that the so-called sleeping brain was charged with activity. Pursuing the study of the eye movements with the EEG brain-wave machine, Kleitman and William C. Dement, a medical student, delineated the architecture of sleep. The proverbial "good night's sleep," they found, actually consists of two sleeps: rapid eye movement, or REM, sleep, a name both Dement and Aserinsky claim to have coined, and non-REM.

Our nightly repose begins with about 90 minutes of non-REM, during which our brain waves gradually lengthen through four distinct *(Continued on page 802)*

A THREE-MONTH-OLD infant spends about 40 percent of a 14-hour sleep budget in REM. An adult sleeps about 7.5 hours, with 20 percent of that in REM. In the 70s, total sleep time has decreased to about six hours, but the proportion of REM stays at about 20 percent.

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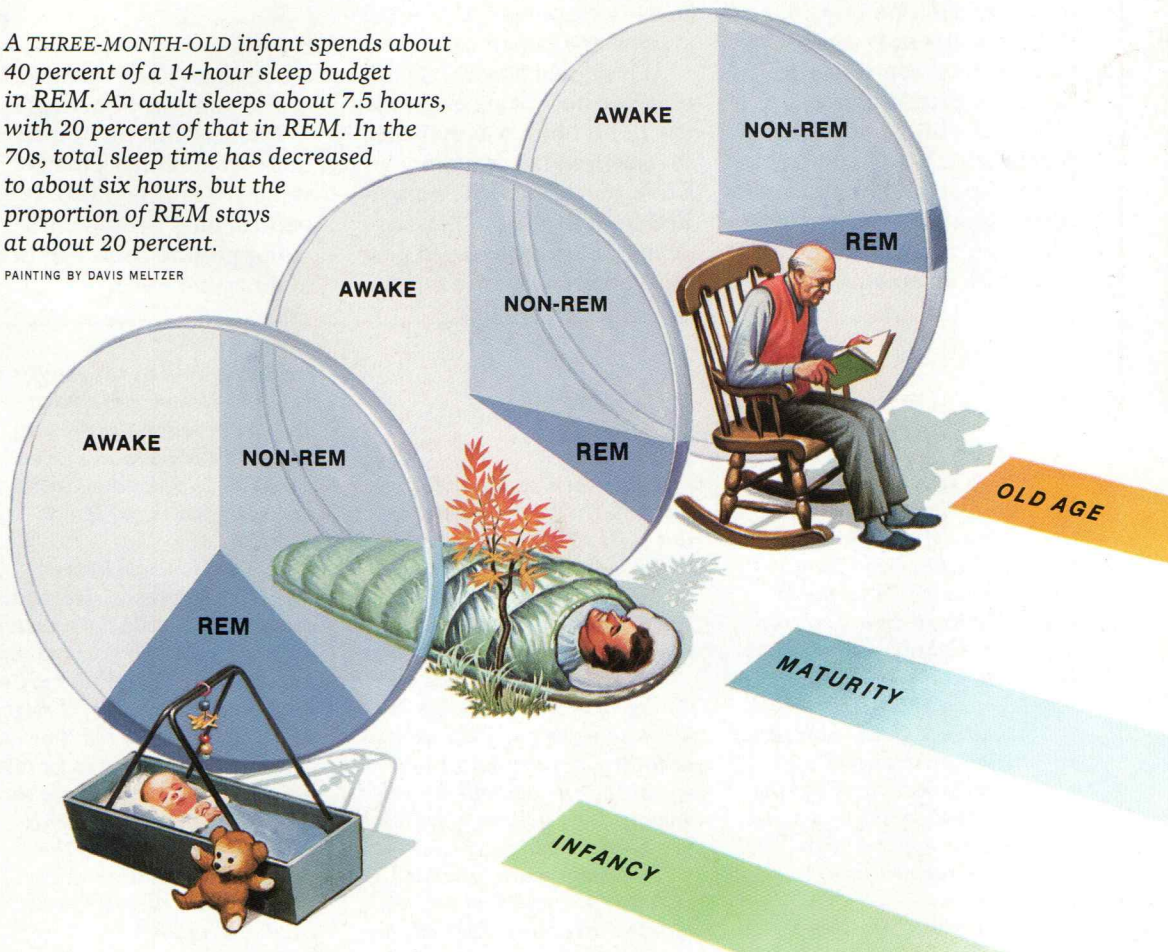


An Exercise in Sleep

CONNOISSEURS OF SLEEP do it to a turn, according to Dr. J. Allan Hobson, professor of psychiatry at the Harvard Medical School. "Some people think they don't move at all," says Hobson. "They swear to you that they go to bed and never change position. Not true. My studies show that everybody makes at least 8 to 12 major posture shifts a night. Insomniacs may double or triple that."

A night's sleep consists of four or five cycles, each of which progresses through several stages. (See pages 797-99 for an analysis of the cycles.)

"Two shifts per cycle is optimal," Dr. Hobson says. "One shift typically ends stage four, and the other concludes the succeeding REM phase."

To make his point, Hobson collaborated with Ted Spagna in photographing filmmaker Allen Moore approximately every four minutes during the night with an automatic camera. A six-watt night-light provided illumination in a room at the Harvard sleep laboratory.

The photographic record shows that in four sleep cycles Moore shifted nine times, one more than an ideal score. "He's really an enviable sleeper," says Hobson.

Too many movements constitute "tossing and turning" and make for poor sleep, but too few shifts—sleeping like a log—may be worse.

"Alcohol reduces REM sleep and inhibits movement," says Hobson. "Drink yourself into a stupor and you risk 'Saturday-night paralysis.' You can kill a nerve in one night just by lying on it—for example, the radial nerve in the upper arm."

At midnight Moore (right) slips into bed. Scalp electrodes record his brain waves in an electroencephalogram, or EEG, represented in abbreviated form by the top horizontal line. Electrodes taped near his eyes record his eye movements in an EOG, or electro-oculogram, the bottom line.

After settling in, Moore turns from his back to his stomach, causing the heavy vertical lines that record a major posture shift, and begins his quest for sleep.

What's in a dream?

Upon waking at 6 a.m., Moore sits on the edge of the bed and transcribes a dream, probably from the REM period from which he awoke. It's a fairly straightforward dream, according to Dr. Hobson. Expert interpreters should figure it out by the end of the second paragraph.

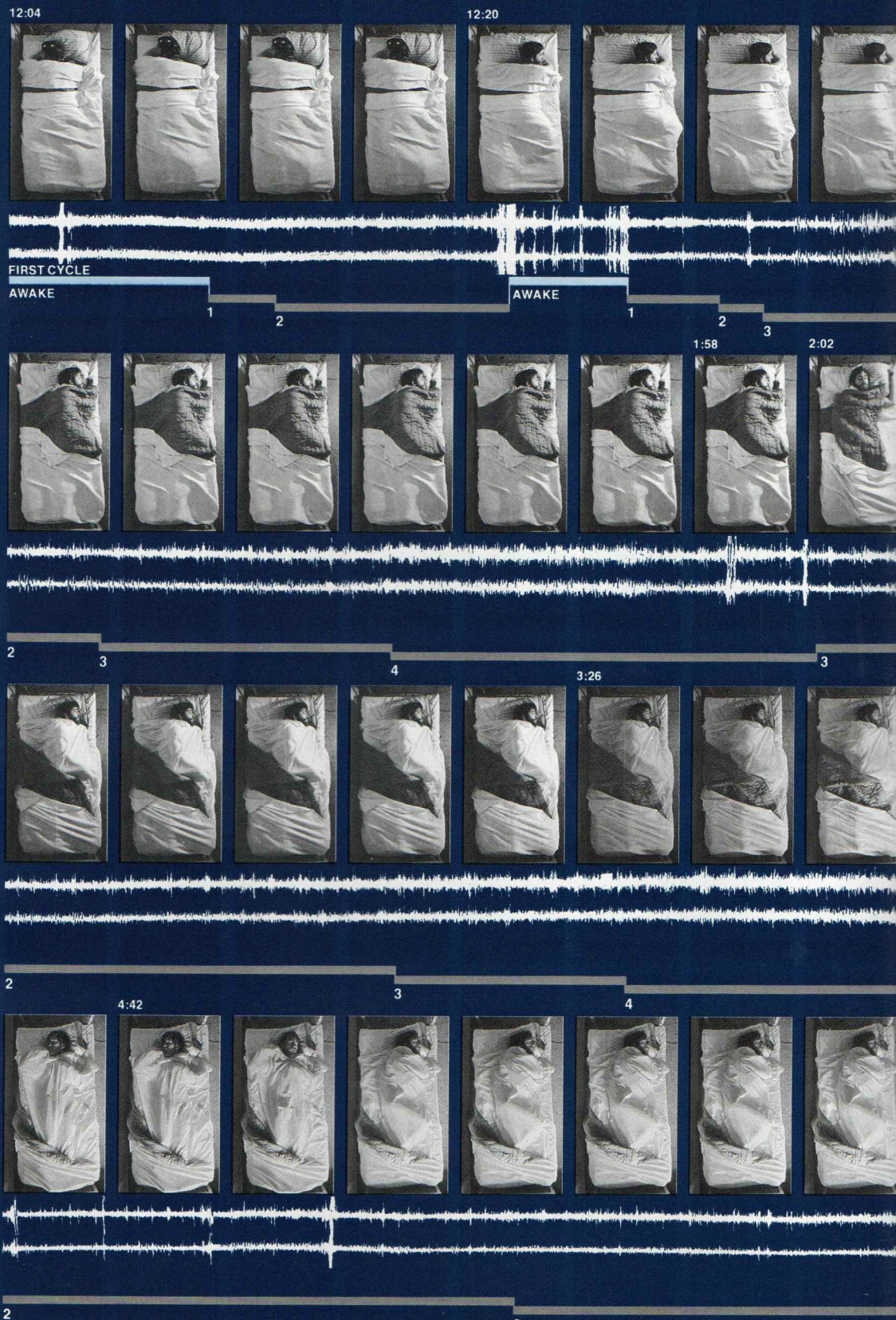
At a banquet Moore observes an "intriguing stranger" and maneuvers to meet her, but the scene suddenly shifts as a maintenance crew appears with "lots of pipes" to repair ceiling sprinklers.

He continues: "One large pipe was now open at one end, and I thought, 'Is there no water in this system?' Suddenly hail began to fall everywhere. . . . The sprinkler system had burst. Everyone ran for cover as the room was thick with hailstones.

"I found shelter in a locker-room and realized I had only wet blue jeans on. They were saturated. On the floor I noticed my green raincoat and my yellow rain hat, neither of which I had been wearing.

"I now desperately needed to urinate but could find no free toilet in this room. All were occupied. I went to the shower and began to relieve myself there. The drain in the shower was now like a bowl, and I filled it very fast, then held myself as it drained, and then filled it again."

Dr. Hobson comments: "Wearing wet jeans, Moore is seeing pipes, sprinklers, water, a hailstorm, his discarded rain hat and raincoat. With only one of these water images, it might be a reach. But by the time he's finished, you'd have to be really hardheaded not to believe that there was some relationship between the content of the dream and urination. The dream speaks directly to his need to urinate."



FIRST CYCLE: *Moore settles right in but gets stuck at stage two. He rolls over at 12:20 to make another try, and in 15 minutes is purring away in stage four. Moore rolls over at 12:58 in a brief moment of wakefulness. His changing brain waves herald the approach of REM.*

The first REM period begins at 1:17 but, typically, shows only a few eye movements. A major posture shift at 1:24 signals the end of REM, which is followed by another brief arousal.

The first cycle spans 84 minutes, including eight minutes of REM.

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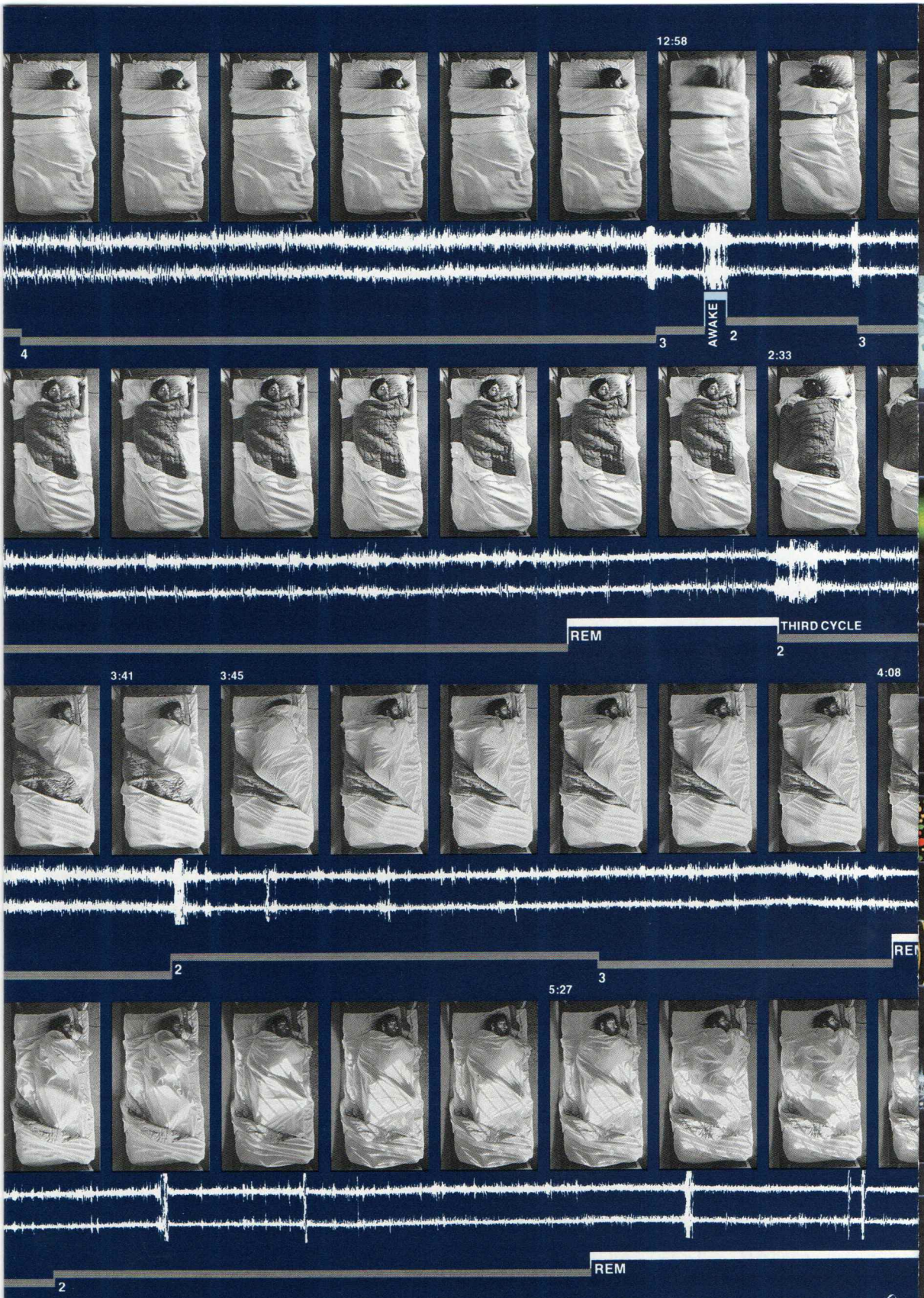
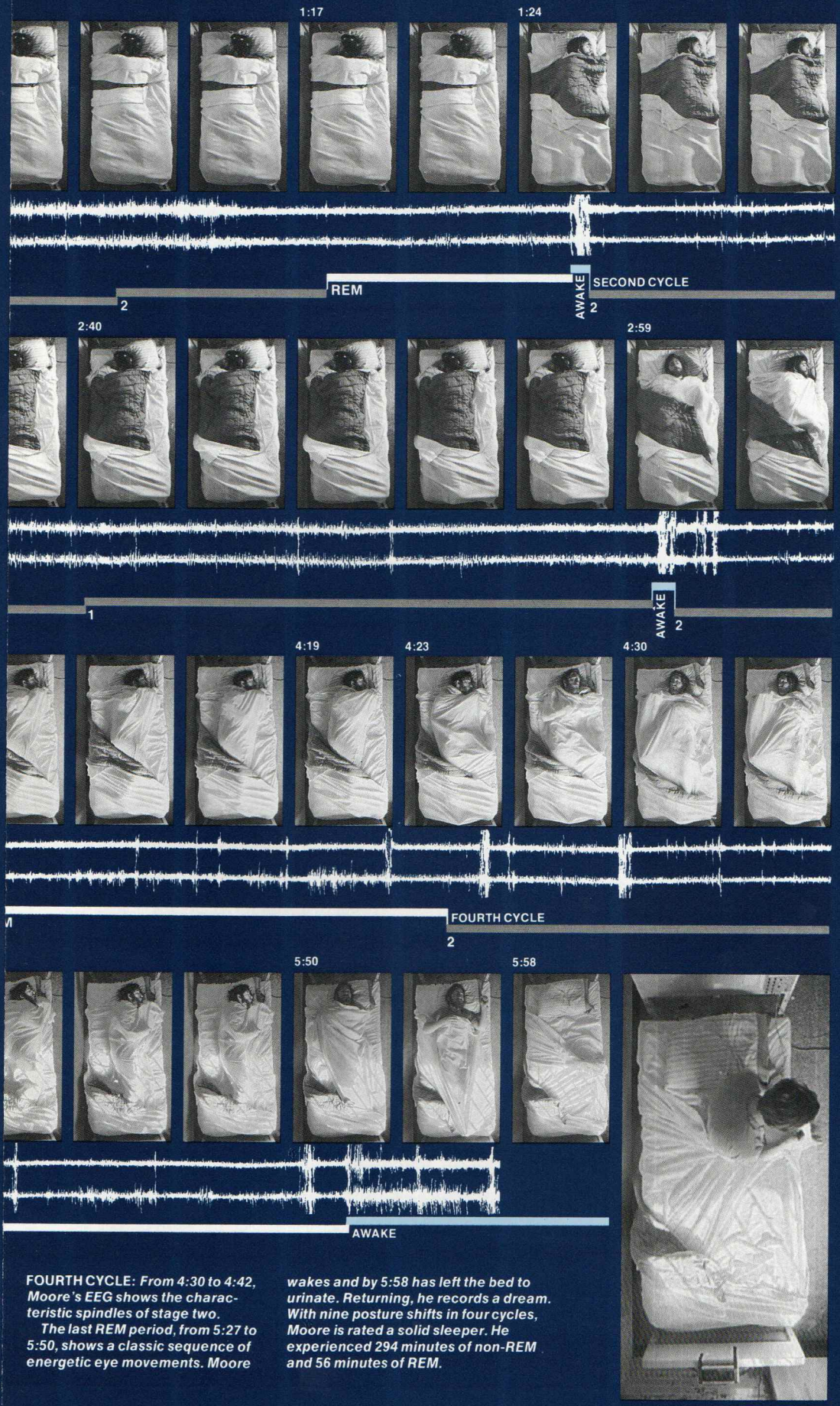


LE: This cycle's stage ly shorter and less in- first. Moore exits olling onto his back and 2:02.

The jagged lines in the bottom channel indicate eye movements of Moore's second REM period, which terminates with a posture shift in the 2:33 frame to begin the third cycle.

THIRD CYCLE: *From 2:40 to 2:59 Moore shows very light sleep with twitching that indicates poor and fragmented sleep. Then he rolls over and proceeds to stage four, which begins at 3:26. The vertical bar between 3:41 and 3:45 is not accompanied by a major posture shift. However, Moore adjusts his bed sheets as stage four terminates.*

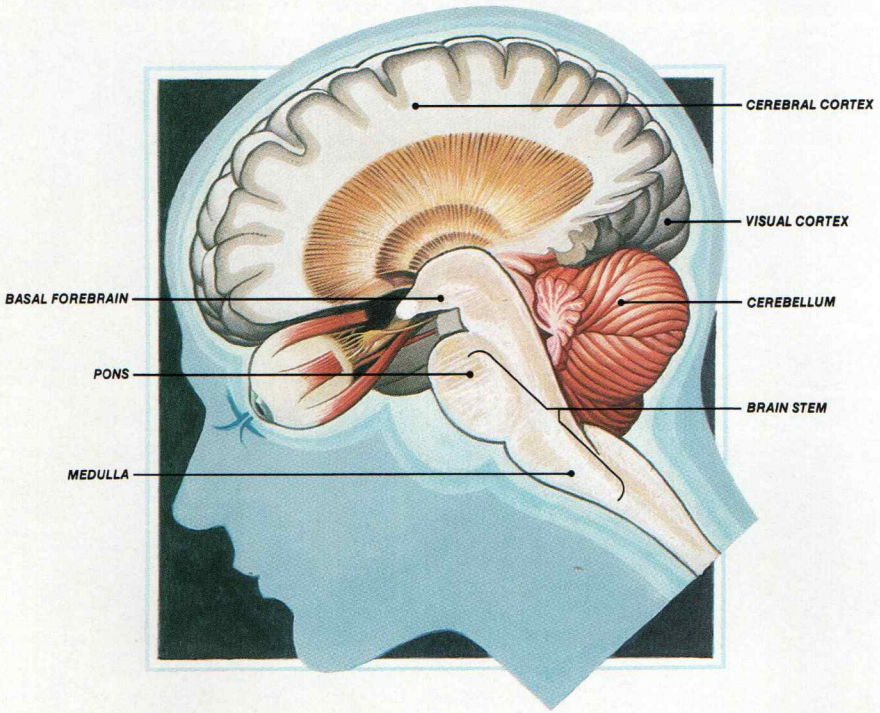
Eye movements become stronger during Moore's third REM period, from 4:08 to 4:23, especially at 4:19. With a posture shift Moore begins his fourth cycle.



FOURTH CYCLE: *From 4:30 to 4:42, Moore's EEG shows the characteristic spindles of stage two.*

The last REM period, from 5:27 to 5:50, shows a classic sequence of energetic eye movements. Moore wakes and by 5:58 has left the bed to urinate. Returning, he records a dream. With nine posture shifts in four cycles, Moore is rated a solid sleeper. He experienced 294 minutes of non-REM and 56 minutes of REM.

The Mystery of Slumber



WHY DO WE SLEEP? For many years scientists thought the brain lapsed from wakefulness because of a lack of sensory stimulation. They saw sleep as a passive phenomenon during which major elements of the brain rested: the cerebral cortex, site of thought, speech, planning, and other high functions; the cerebellum, which coordinates our movements; the visual cortex, which processes neural signals from the eyes into images.

Experiments in the 1940s suggested that the brain itself actively generates sleep. When certain areas of the brain were stimulated by an electric current, sleep ensued. The discovery of rapid eye movement sleep in 1951 gave further evidence of a sleep-active brain. Then scientists identified specific populations of neurons in the pons and medulla of the brain stem that directly affect REM sleep.

Though it is now agreed that sleep is an active phenomenon influenced by particular neurons, the bewildering complexity of the brain continues to prompt debate on the precise location of the neurons and how they interact. Neurons communicate with one another through chemicals called neurotransmitters. Millions of such interactions are necessary for you to read this sentence.

"Sleep may not be the result of one or even of several discrete sleep centers," says Dr. Wallace B. Mendelson, a sleep specialist at the State University of New York at Stony Brook. "Possibly it results from the complex interaction of sleep-generating neurons with neurons that control such other aspects of physiology as respiration and blood pressure."

The ultimate question may not be what turns neurons on, but why. Some theories: By lowering the body's thermostat, sleep conserves energy. REM sleep may also facilitate learning or brain development or reinforce individual behavior patterns.

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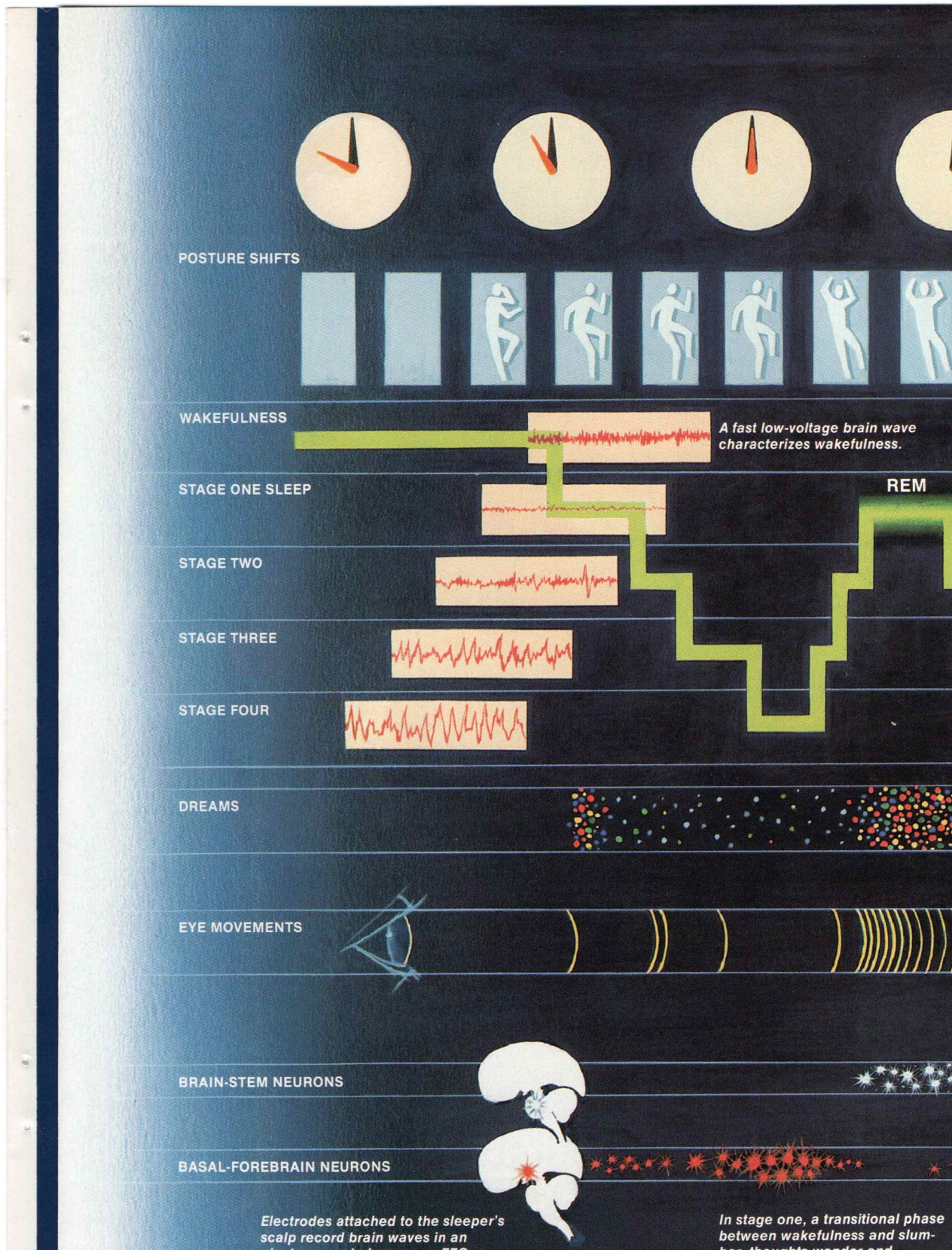
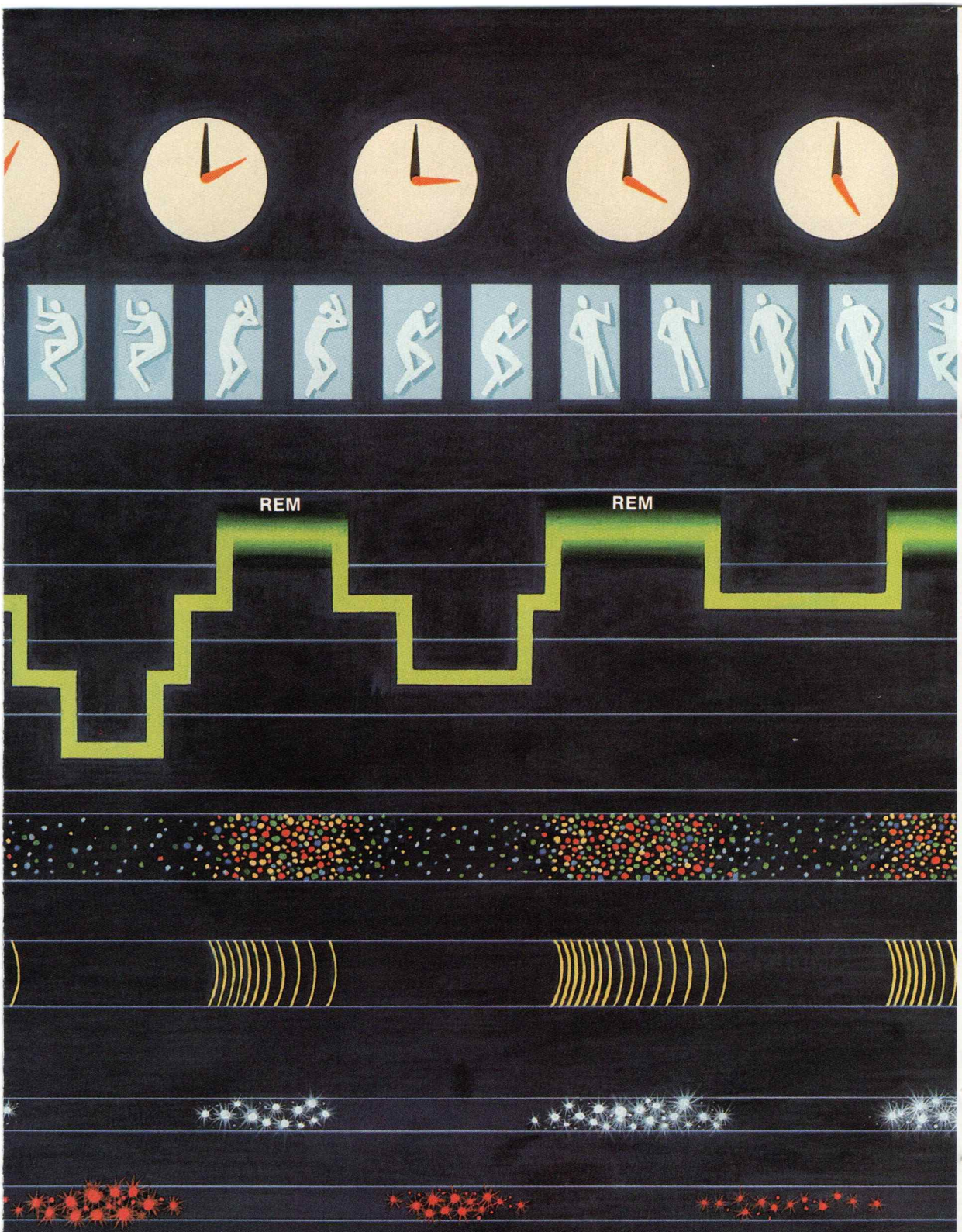


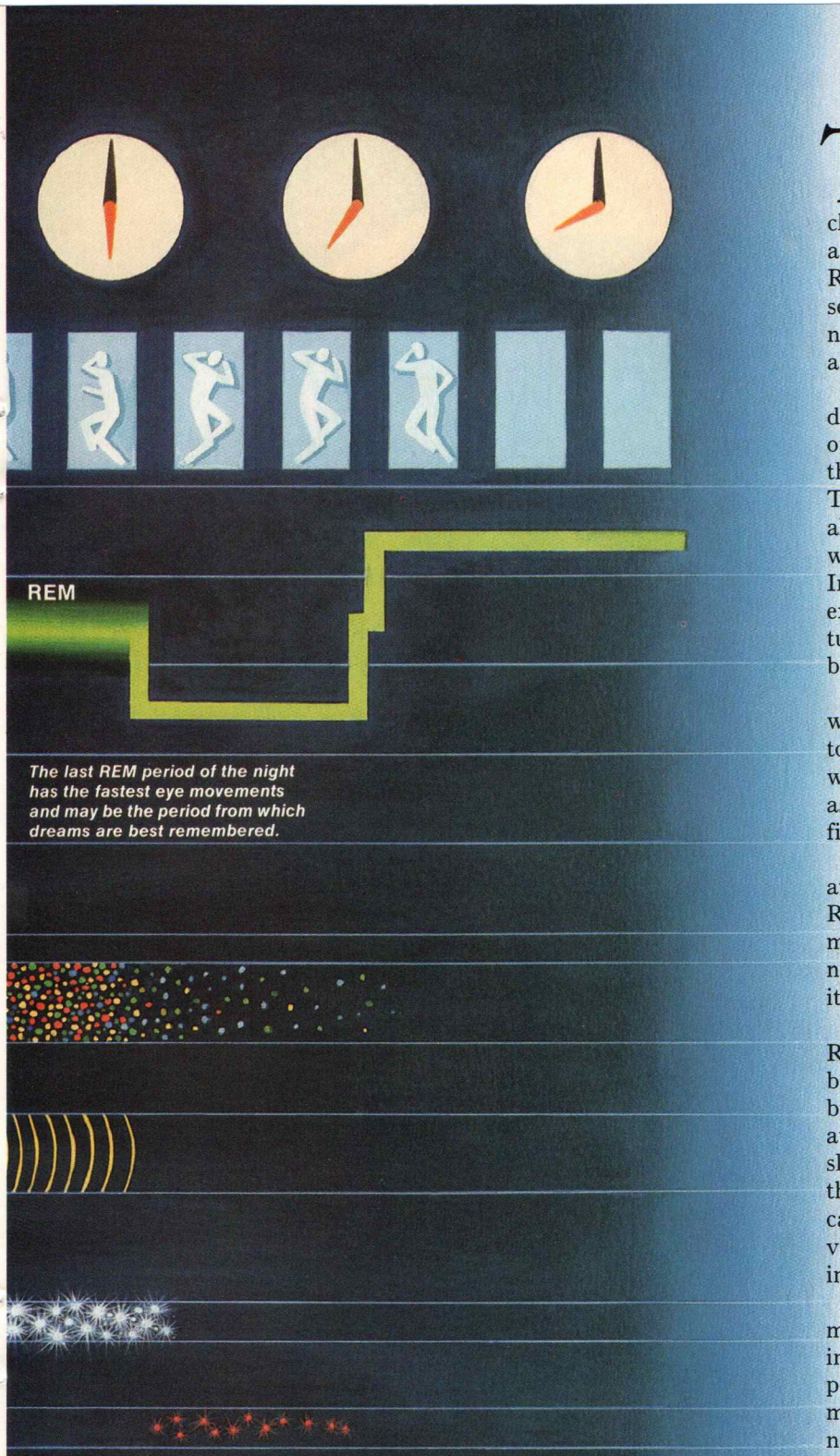
Electrodes attached to the sleeper's scalp record brain waves in an electroencephalogram, or EEG. Other electrodes near the eyes detect bursts of eye movements in an electrooculogram (EOG). In an electromyogram (EMG, not shown here), chin electrodes record the muscle paralysis, or atonia, that accompanies REM sleep.

In stage one, a transitional phase between wakefulness and slumber, thoughts wander and dreamlets may occur. Stage two, the first phase of unequivocal slumber, is marked by jagged spindles in the EEG.



Stages three and four are characterized by delta waves of high amplitude. Heart rate and blood pressure reach their lowest points during stage four. Respiratory rate has decreased, pupils have constricted, and blood flow to the brain is reduced.

The EEG pattern of REM sleep resembles that of wakefulness, hinting at the physiological turmoil taking place. During REM, heart rate, blood pressure, and breathing become irregular. Though muscles may twitch, the sleeper is for all practical purposes paralyzed. Cerebral blood flow increases and thermoregulation is suspended as sweating and shivering cease. Men experience erections, women clitoral engorgement and, some evidence shows, increased uterine contractions. The function of these changes remains unknown.



The last REM period of the night has the fastest eye movements and may be the period from which dreams are best remembered.

Everyone dreams throughout the night, but we remember our dreams to varying degrees or perhaps not at all. REM periods provide vivid and bizarre imagery that can include color and sound.

The mental activity of non-REM periods tends to be thought-like and straightforward, though full-blown visual dreams can occur. Some lucid dreamers report not only that they are aware they are dreaming but also that they can intervene in their dreams to influence the outcome.

THE MASK OF SLEEP covers a complex system of physiological changes dictated by the ebb and flow of REM and non-REM sleep. The synopsis presented here is idealized, and not all sleep specialists would agree with all details.

We enter slumber in stages defined by telltale changes in our brain waves, indicated by the green stepped lines at left. The compact brain waves of alertness gradually lengthen as we drift into non-REM sleep. In stage four, the brain waves exhibit their maximum amplitude, suggesting that this may be the most restful sleep.

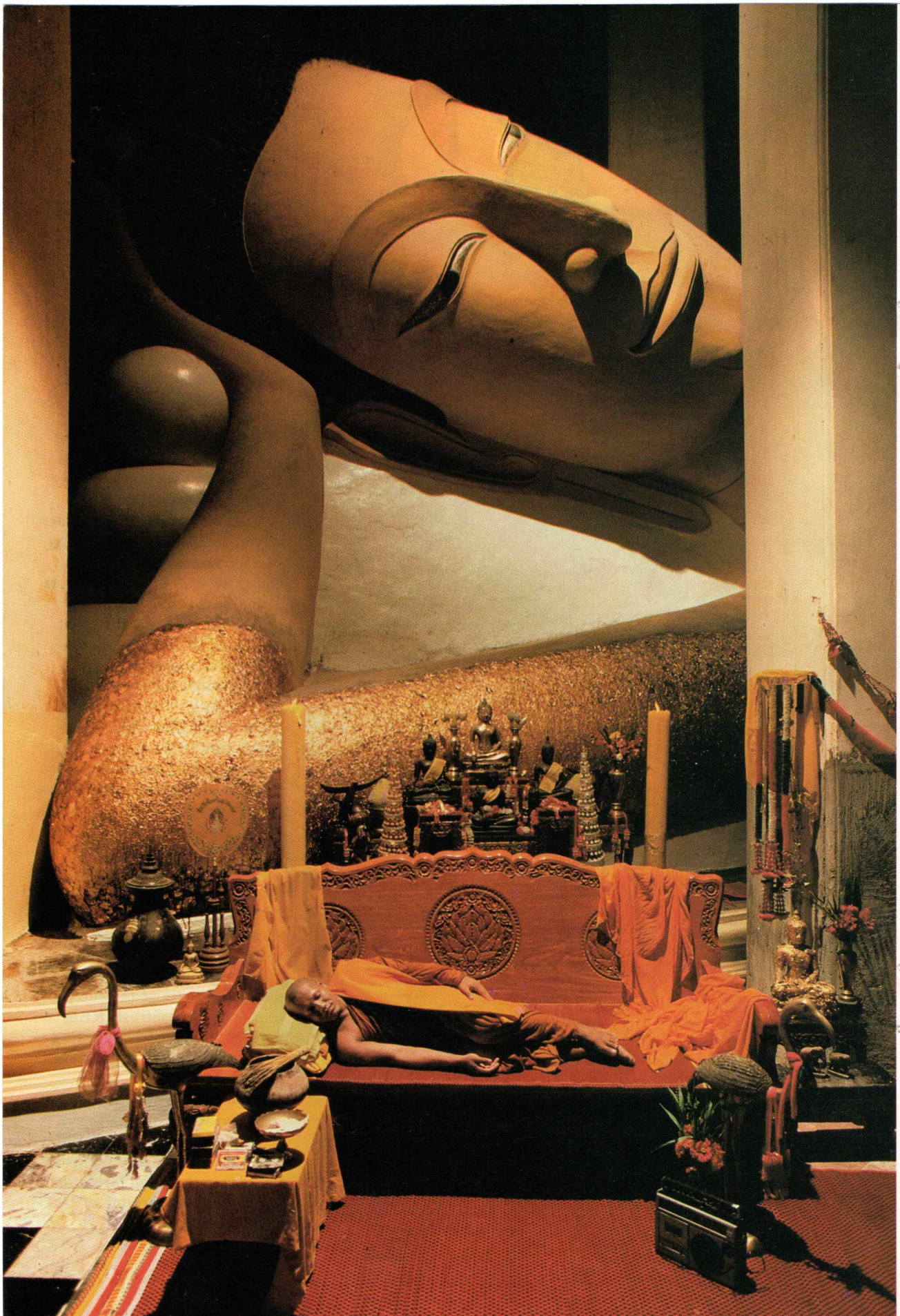
Stage four usually terminates with a posture shift, according to some studies. The brain waves now reverse their course as the sleeper heads for the first REM period of the night.

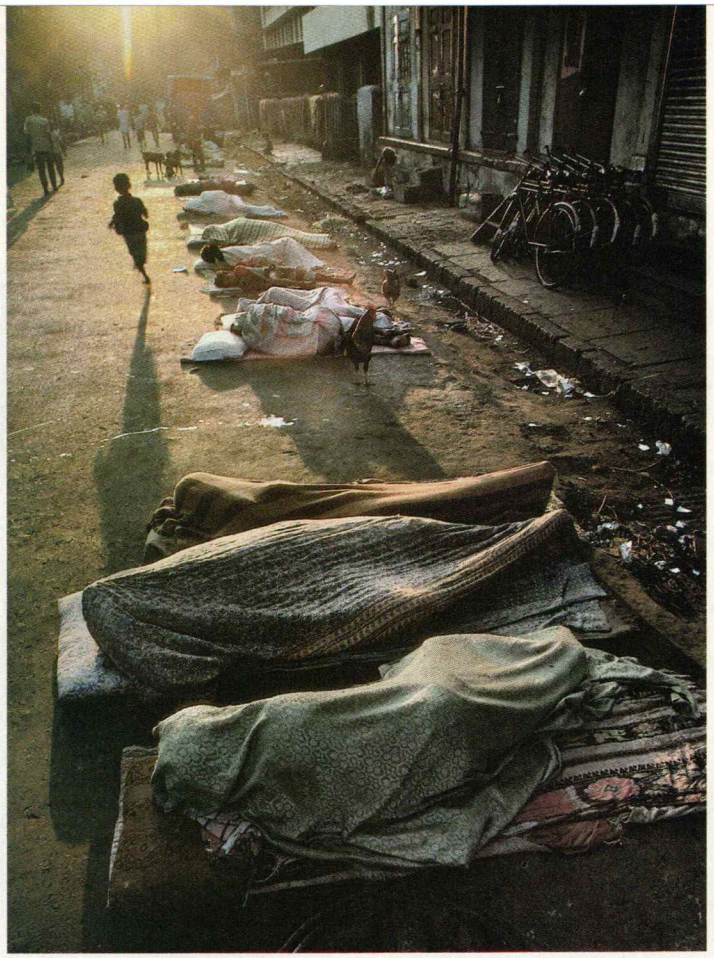
Non-REM sleep is punctuated by increasingly longer REM periods within 90-minute cycles throughout the night. Stage four sleep is limited to two or three episodes.

Sleepers awakened from REM sleep often report vivid, bizarre dreams, indicated here by red and yellow dots. Those awakened from non-REM sleep are more likely to report thoughtlike mentation, indicated by muted dots, though visual extravaganzas can occur in non-REM periods.

Slow, rolling eye movements characterize the entry into sleep. In contrast, REM periods are defined by darting movements whose function is not yet understood.

According to one theory, so-called REM-on neurons in the brain stem generate REM sleep. Another theory points to neurons in the basal forebrain as one of the generators of non-REM sleep.



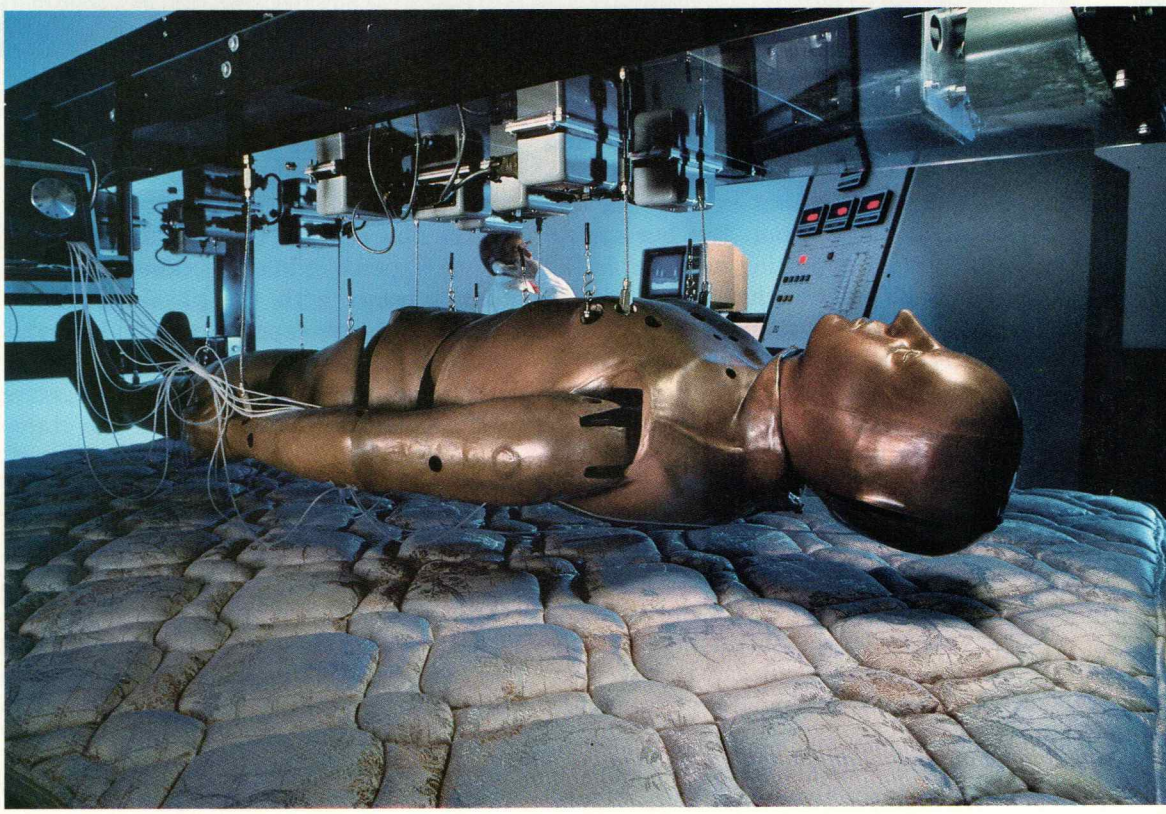


A RECLINING BUDDHA seems to cast a sleepless eye at a sleeping monk in Wat Pra Non Chaksri, Sing Buri, Thailand. At this up-country temple, far from the famous wats of Bangkok, foreign visitors are a rarity, and monks feel free to stretch out on a bench.

A bed can be a luxury in teeming Bombay (left), where people sleep on mats by a gutter and wrap themselves from head to toe in an attempt to dissuade marauding rats.

Striving to build a better mattress, Sealy engineers in Chicago fitted DataMan (below), a modified automobile-testing dummy, with pressure and position sensors.

Bench, street, or luxury mattress, when the need to sleep overwhelms, just about anything serves.



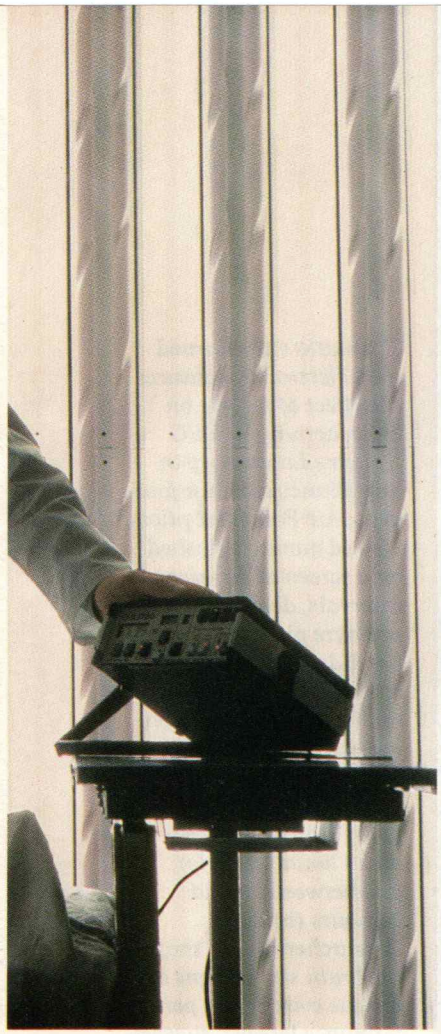
(Continued from page 791) stages, with stage four the deepest sleep. Then the first REM episode of the night begins. An observer sees only that our eyes are moving while our bodies are not. But our central nervous system is putting on a display of physiology so intense that Dr. Frederick Snyder of the National Institute of Mental Health (NIMH) termed it a "third state of earthly existence," distinct from both non-REM sleep and wakefulness.

"The even breathing of sleep gives way to halting uncertainty or panting haste," observed Snyder. "The heart's rhythm now speeds or slows unaccountably; and blood pressure climbs ragged heights or plunges through unpredictable descents. One organ betrays inner excitement still more than the rest, since penile [or clitoral] engorgement almost regularly accompanies these REM intervals.

"The same enlivenment takes place in vital functions throughout the body. Metabolism rises, the kidneys make less but more concentrated urine. . . . Spontaneous firing of nerve cells in many brain regions is increased beyond the level of waking."

The flow of blood to our brains increases about 40 percent; in cats' brains it doubles. Simultaneous with the physiological tumult, the brain experiences vivid dreams involving motion and issues corresponding commands to run, kick, or jump. These are countermanded before muscles can translate them into action—we are paralyzed, unless we experience the disorder of our nocturnal football hero Donald Dorff. After about 20 minutes we stir and drift back into non-REM sleep in a cycle that repeats throughout the night.

Snyder believed that this intense activity served a sentinel function during the course of evolution, priming the body to respond to danger. As Dr. Thomas A. Wehr, director of clinical psychobiology at NIMH, observes: "One visit from a lion, and you were out of



Resetting the body clock

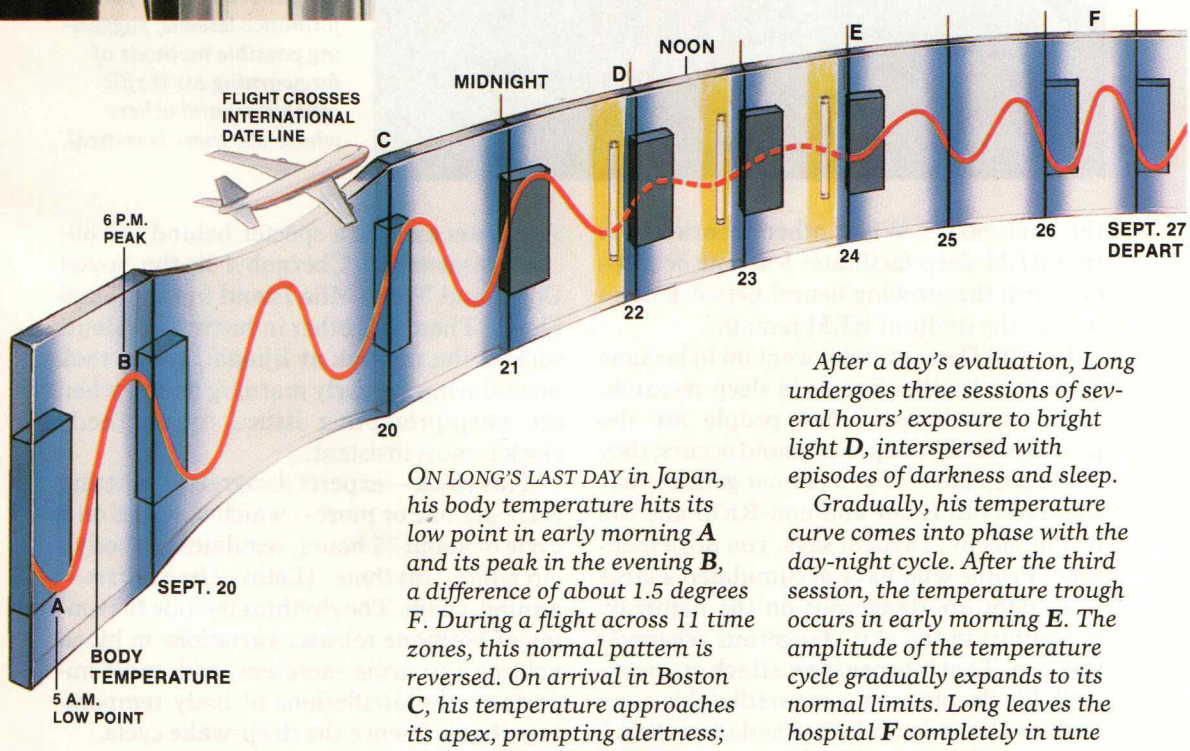
MEASURING LIGHT from fluorescent lamps, Dr. Charles A. Czeisler (left), associate professor of medicine at the Harvard Medical School, reenacts his breakthrough experiment with Dorothy Martin, whose body rhythms were six hours out of phase with her Boston environment. By positioning Miss Martin in front of lights mimicking sunrise or sunset, Czeisler reset her circadian pacemaker.

Czeisler later cured an acute case of rhythm displacement, commonly known as jet lag, that afflicted author Michael E. Long (right). Wearing welder's goggles to screen out sunlight, Long flew from Tokyo to Boston, where he was quarantined at Brigham and Women's Hospital from sunlight and all references to time. Three days of light

KAREN KUEHN

treatments shifted Long's rhythms ten and a half hours, a process that would otherwise take about ten days.

Czeisler's breakthrough could improve sleep for the elderly and rotating-shift workers. It could even banish winter's blahs.

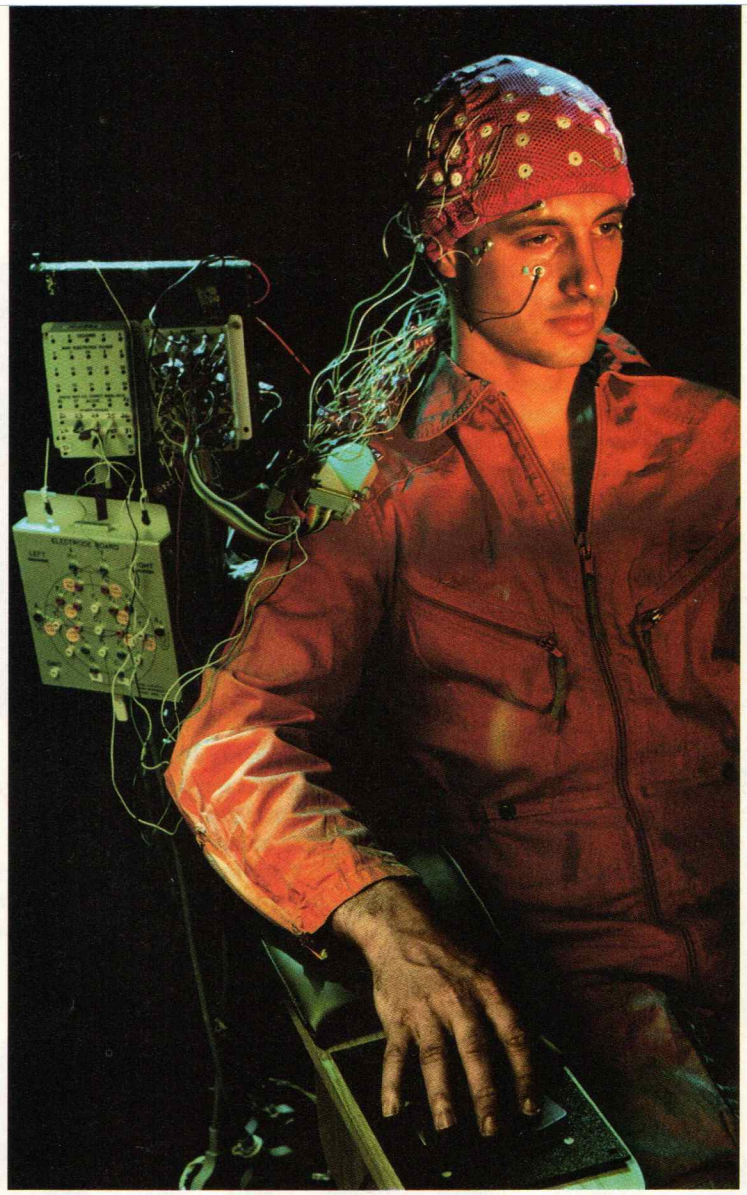


*ON LONG'S LAST DAY in Japan, his body temperature hits its low point in early morning **A** and its peak in the evening **B**, a difference of about 1.5 degrees F. During a flight across 11 time zones, this normal pattern is reversed. On arrival in Boston **C**, his temperature approaches its apex, prompting alertness; the local time is midnight.*

*After a day's evaluation, Long undergoes three sessions of several hours' exposure to bright light **D**, interspersed with episodes of darkness and sleep.*

*Gradually, his temperature curve comes into phase with the day-night cycle. After the third session, the temperature trough occurs in early morning **E**. The amplitude of the temperature cycle gradually expands to its normal limits. Long leaves the hospital **F** completely in tune with his surroundings.*

PAINTING BY NATIONAL GEOGRAPHIC ARTIST WILLIAM H. BOND



THINKING CAP adorned with electrodes measures the effect of fatigue on brain activity at EEG Systems Laboratory in San Francisco. Over four days, Air Force test pilots viewed numbers flashed on a screen at six-second intervals, depressing a pressure plate if a number did not duplicate the one shown 12 seconds earlier. Computer graphics (right) depict the occurrence of certain brain waves during the first 7 hours (top), between 7 and 9 hours (middle), and between 10 and 16 hours (bottom). Researchers found that the brain shows signs of fatigue even before performance lessens, suggesting possible methods of forewarning air traffic controllers and others whose alertness is critical.

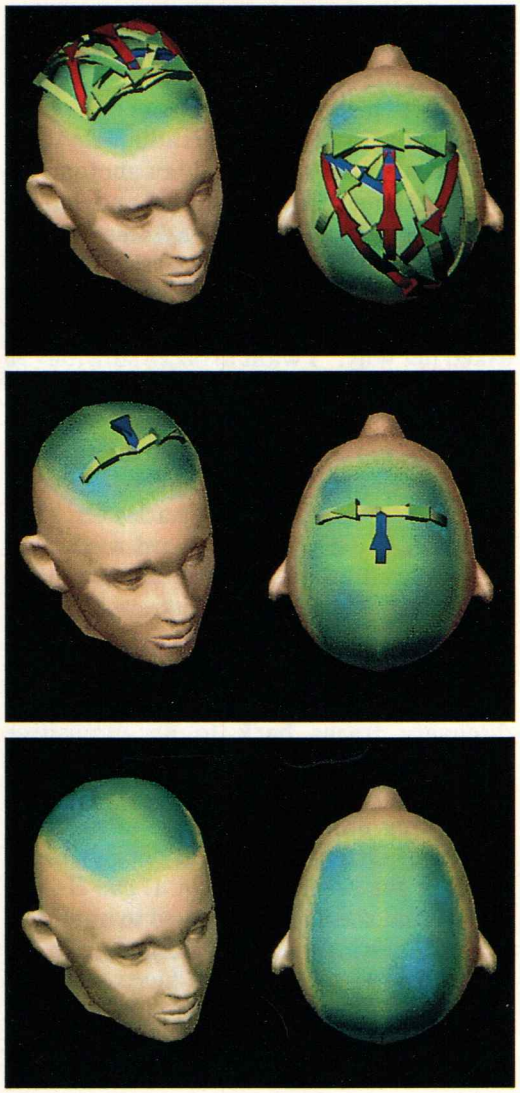
the gene pool." While other theories hold that REM sleep facilitates learning or helps establish the growing neural network of an infant, the riddle of REM remains.

Dr. Bill Dement, who went on to become one of the leading figures in sleep research, demonstrated that when people are deprived of REM sleep, a rebound occurs; they make it up later. If you are not getting your share of both REM and non-REM and are feeling sleepy, Dement says, you are a menace. "People who have accumulated a large sleep debt are dangerous on the highway, dangerous in the sky, dangerous wherever they are. That is because an attack of uncontrollable sleepiness is as unpredictable as an earthquake and may be just as devastating."

Indeed, Dement and other experts feel sleepiness may be a specter behind the nuclear disasters at Chernobyl in the Soviet Union and Three Mile Island in the United States. These and other industrial accidents such as the gas leak at Bhopal, India, took place during the early morning hours, when the sleep-prompting issued by our body clock is most insistent.

This clock—experts disagree on whether there are one or more—which operates on a cycle of about 25 hours, regulates the body's circadian rhythms (Latin *circa diem*—around a day). The rhythms include the timing of hormone release, variations in blood volume and urine excretion, and, most important, the oscillations of body temperature that influence the sleep-wake cycle.

Until 1980 most scientists accepted the



commonsense notion that onset of sleepiness and the amount we sleep are determined primarily by the waking activity that precedes them. Dr. Charles A. Czeisler, associate professor of medicine at the Harvard Medical School, overturned this assumption by showing that our body clock, which prompts a temperature decline at night, determines when and how long we will sleep. One of the most significant findings of sleep research, this explains the difficulties experienced by those who toil through the night.

"The worst time is the body's temperature trough in the latter part of the night," says Czeisler. "Then, as any shift worker will tell you, sleep seems almost irresistible."

So it must have seemed to the control-room personnel who fell asleep at the Peach Bottom nuclear plant in Pennsylvania this year, a breach so serious that the Nuclear Regulatory Commission closed the plant. And to the fatigued intern and residents of New York Hospital blamed for mistakes uncovered by a grand jury investigation into the death of a young woman patient. The tragedy prompted the state to recommend that emergency-room duty tours be reduced to 12 hours from the 36-hour stretches designed to "toughen" young doctors.

EVEN ORDINARY SLEEPINESS can cause mistakes, according to a study conducted by Dr. Torbjörn Åkerstedt of the Karolinska Institute in Stockholm. He instrumented 11 locomotive engineers on runs between Malmö and Stockholm with electrodes measuring their brain waves and eye movements.

The engineers, he found, divided into an "alert" group of five engineers and a "sleepy" group of six. Exhibiting drooping eyelids and brain waves associated with nodding off, all of the sleepies dozed during the trip, but only four admitted it. Two of them careened through warning signals, for all practical purposes asleep. Åkerstedt's research shows that when body clock and work schedule clash, people can drift in and out of so-called microsleeps without being aware of them.

Such assaults on body rhythms afflict an estimated 60 million shift workers, says Dr. Martin C. Moore-Ede, associate professor of physiology at Harvard and a circadian rhythms specialist. Moore-Ede has worked with 50 companies worldwide, including utilities that operate nuclear power plants, helping to revamp schedules and train personnel to stay awake. "Most managers are not aware that as many as 80 percent of their workers are nodding off on the night shift," he says.

"The typical shift worker rotates from the day shift to the night and then to the evening shift. This routine is like working a week in Denver, a week in Paris, and a week in Tokyo. Put a lone operator in a dimly lit, automated computer control room with nothing important to do, and you almost guarantee the worker will fall asleep," he says.

Though airlines continue to provide one of the safest forms of transportation, pilot

sleepiness is a real—if seldom discussed—issue. Moore-Ede describes the wear and tear to the circadian rhythms of crews who fly day and night across multiple time zones: "They sleep about two hours less than usual on trips, so they're sleep deprived, and they operate at all hours in the cramped, monotonous, dark environment of the cockpit."

He told me of a jetliner on final approach to Chicago's O'Hare Airport that veered toward the American Airlines terminal building instead of the runway: "Despite being warned by the other crew members, the copilot was in a zombie state—'No problem,' he said. The captain took control."

The management of another airline later approached Moore-Ede, intent on addressing pilot fatigue. Moore-Ede's first priority is to revise crew scheduling, which he says is "totally random and erratic. Billions of dollars are spent optimizing equipment," he says, "but we have an under-investment in the most complex piece of machinery in the airplane, the brain of the pilot."

FATIGUE IS THE ENEMY in a U. S. Army study that used wrist monitors to record levels of activity during 14 days of maneuvers in order to determine which personnel were most likely to suffer from sleep deprivation. At MIT an artificial gravity sleeper rotates with the head at the pivot point. Such a device may help astronauts ward off the detrimental effects of weightlessness in space as they sleep.

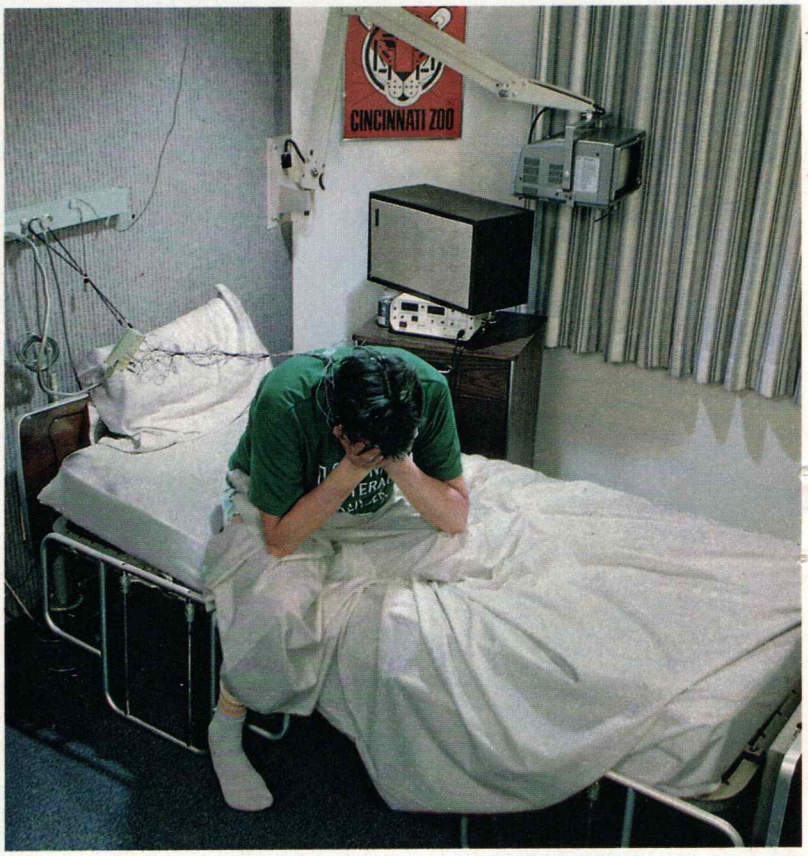
With the airlines' cooperation Dr. R. Curtis Graeber and other circadian-rhythms experts at NASA have ridden shotgun on nearly a thousand international and domestic flights to monitor pilot rhythms and tolerance of jet lag. Graeber noticed during one flight that the chief flight attendant kept coming into the cockpit and finally asked her why. "I want to make sure they're awake," she said.

HELP IS ON THE WAY, thanks to a discovery announced only recently by Dr. Charles Czeisler, the young Harvard researcher who showed how body temperature influences sleep. Czeisler demonstrated that by using bright light he can shift a person's circadian rhythms dramatically, resetting the body clock to whatever time he chooses. His discovery traces back to an inquisitive French astronomer who showed that plants have their own clocks.

Working probably with a mimosa, Jean Jacques d'Ortous de Mairan deprived it of sunlight for several days in 1729. He observed that the plant continued to unfold its leaves in the morning and close them in the evening, even in the dark. Thirty-one years later his countryman Henri-Louis Duhamel du Monceau, skeptical that a plant could possess a clock capable of regulating its activities, repeated the experiment and found that the plant's clock functioned independently of temperature as well as light.

Researchers in the groves of Circadia eventually discovered clocks almost everywhere they looked, from single-celled algae to complex plants, insects, and animals. The clocks' day-night cycle varied from 22 to 27 hours in length but could be synchronized to the solar day by light. Moreover, the light pulse could shift the rhythms of the organism from day to night. The amount of shift depended on when the pulse was applied.

Studying rats and hamsters, scientists determined the location of the body clock—two tiny nuclei of brain cells perched atop the juncture of the optic nerves. Then researchers at Harvard University found similar populations of neurons, called the



TROUBLED MINDS speak through dreams to Milton Kramer (above), director of Cincinnati's Bethesda Oak Sleep Disorders Center. Dr. Kramer, a psychiatrist, views a videotape to study the relationship of EEGs to the sleeping patterns of a five-year-old who awakens from nightmares with intense headaches.

The pulse rate of a wounded Army veteran (right) doubles in 20 seconds during nightmares about combat in Vietnam. The condition is not uncommon among veterans. This man sleeps with the light on and keeps a gun beside his bed. He awakens as many as 15 times a night but has begun to respond positively to psychotherapy.

Victims of nightmares account for less than 10 percent of the center's cases. Of some 800 new patients a year, 60 percent seek help for sleepiness and 30 percent for insomnia.

suprachiasmatic nuclei, in preserved human brain tissue. But how did the human circadian pacemaker work?

In 1978 Czeisler used ordinary room light to demonstrate that human clocks could be synchronized to the solar day by light. When Dr. Alfred Lewy, a colleague then at NIMH, showed that brighter light can suppress hormone release, Czeisler became curious. Suppose he increased the brightness to that of sunrise or sunset—what effect would that have on human circadian clocks? Could it effect the dramatic shifts that had been demonstrated in plants and animals?

Financial support for Czeisler's project came from the U. S. Olympic Committee, which was interested in resetting the clocks of jet-lagged athletes; the U. S. Air Force; and the National Institute of Aging, intrigued about resetting the clocks of the aged, which wind down over time and may contribute to poor sleep.

At Brigham and Women's Hospital in Boston, Czeisler took over a wing where subjects could live isolated from time and sunlight. In August of 1986 he published a startling find. By the application of bright light alone, he had reset the clock of a 66-year-old woman by six hours.

FROM JAPAN, where I was studying sleep research, I called Czeisler and asked if he would cure my jet lag by adjusting my clock when I returned to the East Coast. He agreed with hesitance, saying an 11- or 12-hour shift, the maximum ever required on earth, was a formidable task. "I won't promise you anything except a pair of welder's goggles," he said. "When you're on your way in that jet and the sun comes up, put them on." That would prevent the sunlight from interfering with the experiment.

Approaching the coast of Alaska at 37,000 feet on Japan Airlines Flight 008, I savor my final moments without goggles. Faint tracks of brightness are limning the eastern horizon—dawn. I put on the goggles and, feeling like a troglodyte, slink into my seat to avoid the stares of fellow passengers.

In Boston, Czeisler and his associate James S. Allan usher me into an apartment where time does not exist—no windows, no clocks, no TV, no radio, no newspapers or magazines. After a few hours' sleep the first order of business is to ascertain whether my body clock still runs on Tokyo time.

This means charting by rectal probe the oscillations of my deep, or core, body temperature. To rule out variables, Czeisler subjects me to 19 hours of a "constant routine," a regimen of small, frequent meals, no sleeping or napping, and confinement to bed. This is rigidly enforced. Just my feet hitting the floor would release a flood of hormones and influence temperature.

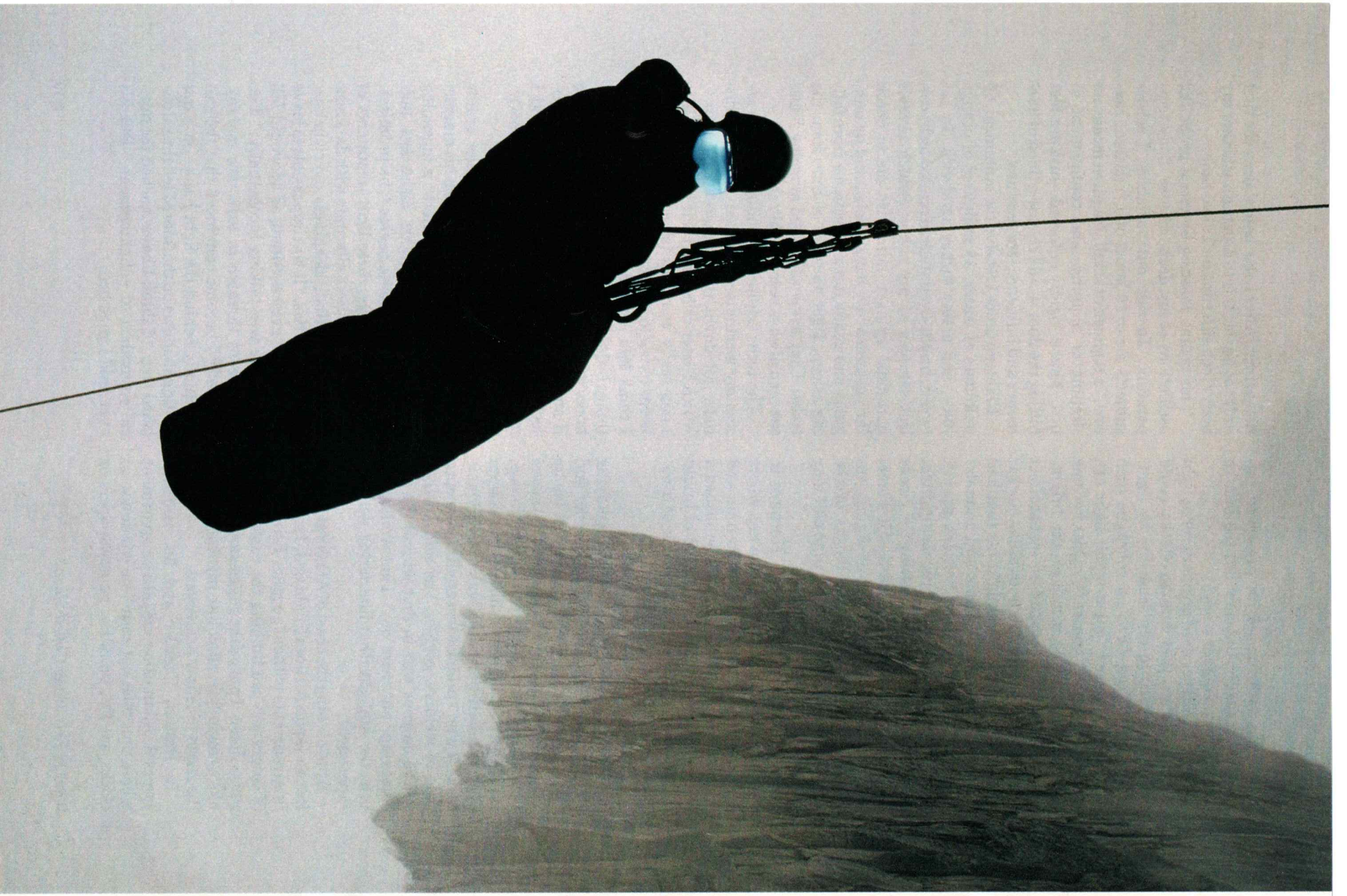
Eighteen times I receive the same meal: 69 milliliters of water, 35 milliliters of orange juice, and a tiny turkey sandwich. In between, bright-eyed students called techs collect samples of my saliva (which reveals hormonal swings), admonish me to check the position of my rectal probe, and by talk, guile, and gentle force prevent me from falling asleep. I get no sense of time from the techs. They never say "good morning," and the men always seem freshly shaved.

The techs administer endless tests to assess my alertness and mood. They continually jot down their observations of me, which I later crib from their logbook: "Mr. Long really wants to take a nap. He also keeps trying to figure out what time it is. . . . I think he's getting annoyed about all the things he has to do. . . . Mr. Long is dying to know what Notre Dame did on Saturday, so if anyone knows, please tell him. . . . Subject is very sleepy, but Dr. Czeisler and I managed to keep him awake." And finally, "Subject was thrilled to go to sleep."

At last the routine ends. Czeisler grants me some sleep, then switches on his magical device to reset my body clock: a humming fluorescence of 60 lights eight feet tall. "Your journey home begins," he promises.

For three days, three light treatments of several hours apiece alternate with darkness and rest. At first, sleepiness overwhelms, and a tech writes, "It was impossible to leave Michael for even a minute as he would fall asleep. He was talking incoherently." The microsleeps threaten to turn into macros.

Finally I become convinced that the sun is actually behind the light bank—is it not casting shadows on the floor? I tell the astonished tech, "I think I have reached the optical equivalent of enlightenment." But it's over, and I go to bed.



I awaken to a welcome sense of relaxation. Then I hear a tapping noise from outside. I realize it is a hammer. My thoughts race: Hammer means carpenter means—morning! Czeisler has done it. I have awakened on eastern daylight time, U.S.A.

Back we go to the constant routine to see if my clock has actually been reset: 32 more hours of wakefulness, soggy turkey sandwiches, confinement to bed, and the cursed probe. When it is done, Czeisler is jubilant. The test has certified the arrival of my rhythms on the eastern seaboard with an astonishing shift of ten and a half hours over just three days. Normally, Tokyo-to-Boston jet lag takes ten days to cure by itself.

Later we step outside to experience a sunlit September morning. I feel completely in tune with it and with my surroundings. My jet lag has vanished in the lights.

Since then, experiments with more than a dozen subjects have given Czeisler and his Harvard colleague, mathematician Dr. Richard E. Kronauer, unprecedented insight into the way bright light affects the body's rhythms. The first two light episodes in a series, they have found, can flatten the amplitude of a subject's temperature cycle, preparing the clock for resetting. The third episode can then more easily move the clock's hour hand. "It's as if the first two shots would put the subject at the North Pole," said Czeisler. "Then with a step he can go to any time zone."

Czeisler and other sleep scientists see dramatic possibilities ahead. One lies in easing the troubled sleep of the elderly. "If we can increase the amplitude and reset their pacemakers," said Czeisler, "they might sleep more like they did in their 20s." Other potential benefits include alleviation of jet lag and shift-work disabilities. "We can install lights in factories and airplanes to help rhythms adjust while people are working and traveling. There could be light solaria at airports and perhaps a new brand of jet travel, Light Class."

For NIMH's Dr. Thomas Wehr, Czeisler's breakthrough offers a new weapon in the war on depression. "We see a flattening of certain rhythms in the depressed," he said. "They're not fully awake, not fully asleep. If you increased their amplitude by light and restored these rhythms. . . ." Czeisler and Kronauer think that this may explain why phototherapy helps in the treatment of patients with seasonal affective disorder, a form of depressive illness.

A SURVEY of sleep-clinic patients found that 51 percent of the complaints were from people who had trouble staying awake. The major cause of their sleepiness was apnea—the repeated cessation of breathing, usually associated with snoring. This robbed them of needed rest.

"Snoring is no laughing matter," says Dr. Neil B. Kavey, director of the sleep clinic at Columbia-Presbyterian Medical Center in New York. "It puts a tremendous strain on a marriage. We often ask patients to bring their spouses, and you can see the anger."

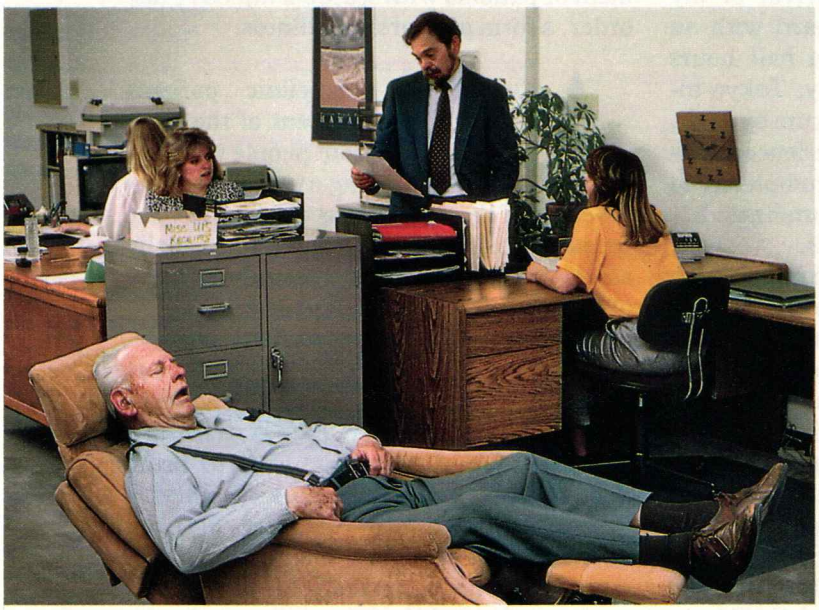
The familiar sound of snoring results from a constriction of the flow of air through passages in the head, causing the soft palate, uvula, and nasal tissues to vibrate. In the most common apnea a physical obstruction exaggerates the constriction. The pharynx collapses and closes, stopping not only the snoring but also the sleeper's intake of oxygen. When the oxygen deficit becomes critical, the central nervous system spurs the sleeper to gasp convulsively for air. He (most patients tend to be male, as well as middle-aged and overweight) resumes the snoring and, though the cycle continues through the night, will often not be aware of it come morning.

Sufferers from severe apnea hardly ever get a sound night's sleep. Many exhibit irrational behavior as well as changes in personality, libido, and intellectual capacity. They can be helped by wearing a breathing apparatus that exerts air pressure on the upper passages to keep them open. The more drastic remedy of surgery removes the obstruction or creates an alternate airway. When subjects finally get a good night's sleep,

TUCKED IN A HAMMOCK, climber Gary Bocarde dangles from Alaska's Mount Barrille to demonstrate a potential use of Tranquilite sleeping goggles. Designed for adverse conditions, Tranquilites are said to induce relaxation with blue light and a soothing "pink sound."

they are amazed at their increased energy.

More than 10 percent of the patients in the survey suffered from narcolepsy, a devil's brew of symptoms that include sudden slumber, hallucinations at sleep onset, and cataplexy—temporary paralysis while awake, most often provoked by laughter but sometimes by other situations. A surgeon falters at the sight of blood, a railway signalman goes limp at the approach of a train, a priest hesitates as he elevates the host.



At Seiwa Hospital in Tokyo I met the man whose research on narcoleptics indicates that the condition is genetically based. Dr. Yutaka Honda pointed to patients asleep in waiting-room chairs as we proceeded to a meeting of members of the Japan Narcolepsy Association, a support group he founded in 1967.

There Shogo Natori, 55, told me of his passage through the thickets of narcolepsy. "I began to experience sleepiness when I was a teenager," he said. "People told me I was just being lazy, so I pinched myself to keep from falling asleep. It was painful, and it didn't help. When I fell asleep in class, the teacher became angry and beat me."

When Natori joined his brothers as a carpenter, they covered for him during sleep attacks on the job and repaired his shoddy work. Later he became a contractor. "When I was talking on the phone, I was fine, but as soon as I finished, I would fall asleep. The ringing of the phone would wake me up again. I couldn't stay awake for more than half an hour; I couldn't finish writing a single page. I was bumping into people on the street."

Natori came to Honda, who prescribed the stimulants and antidepressants that enable narcoleptics to cope. "Now I can stay awake when I talk to you," he said. "Before, I would have fallen asleep long ago."

The ultimate cure for narcolepsy may be in sight, says Dr. David Parkes of Kings College Hospital, London. "It rests with molecular biologists and the brave new world of gene-replacement therapy."

A large number of surveyed patients complained of insomnia, a mask for many conditions, according to Dr. Wallace B. Mendelson, a sleep expert at the State University of New York at Stony Brook. "Insomnia itself is not an illness," he says. "You need to find out what's causing the insomnia and treat that." Leading candidates are psychiatric disturbances, anxiety, drug and alcohol dependency, and myoclonus—jerking of the legs—that wakes one up.

Strangely, 10 percent of sworn insomniacs sleep soundly when they come to a clinic. "Then they tell us they've been wide awake all night," says Mendelson, who has studied this phenomenon with insomniacs and normals. "In one experiment we woke them up ten minutes after the EEG certified they were asleep," he said. "All the normals said they had been sleeping; the insomniacs said they'd been awake." However baffling insomnia seems to be, Mendelson offers the consolation that "we know of no one who has died from it."

Small doses of sleep itself—napping—may cure much of what ails us, according to Dr. Jürgen Zulley, a young psychologist at the Max Planck Institute for Psychiatry in Munich. He has found evidence for a four-hour sleep-wake cycle with nap periods at approximately 9 a.m., 1 p.m., and 5 p.m.

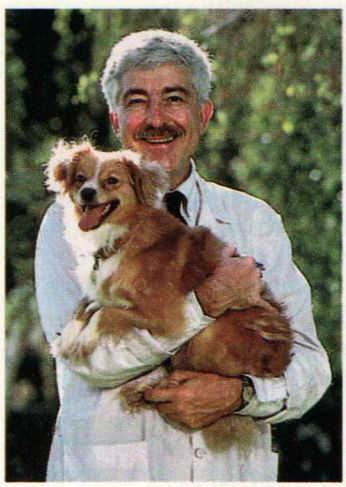
Zulley feels we shouldn't always fight our natural drowsiness at these times with coffee breaks or exercise. "A short nap, just leaning back in your chair, is better," he says.

Zulley's study puts him in good professional company, I learned while spending a day with one of the world's most dedicated sleep researchers. About four o'clock in the afternoon Dr. Allan Rechtschaffen of the University of Chicago yawned and terminated the interview: "Excuse me," he said. "It's time for my nap. I've always done this, but now we know it's biologically correct."

THOUGH NOT FORMALLY categorized as a sleep disorder, the mysterious sudden infant death syndrome, or SIDS, strikes sleeping infants without warning, and autopsies yield no explanation.

In New Zealand, where SIDS is known as cot death, it shows a strange selectivity:

SUDDEN SLEEP and sudden paralysis are twin devastators from narcolepsy and a frequent symptom, cataplexy. At Stanford University in California, Dr. William C. Dement (right) holds Tucker, awake but limp from a cataplexy attack provoked by the sight of food. Moments earlier the dog, a member of Stanford's colony of narcoleptic animals, appeared normal. For humans, the most



common trigger for cataplexy is laughter.

A pioneer in the study of rapid eye movement sleep and dreams in the 1950s, Dement became a tireless spokesman for sleep research and a magnet who attracts brilliant students to Stanford.

At the headquarters of the American Narcolepsy Association in Belmont, California, Ray Johanson sleeps off a narcolepsy attack (facing page).

Maoris seem to be afflicted more than twice as often as white Kiwis, while recent Polynesian immigrants fare best. Dr. Shirley Tonkin, a SIDS specialist with the Auckland Department of Health, took me to the home of Mrs. Materangatira (Mate) Webb, a Maori who, by a primal instinct that only a mother can comprehend, saved her son.

"I was cleaning up," said Mate, "and something told me to go into the bedroom. Tareha was turning purple and not breathing. I picked him up and shook him, but he just wouldn't wake up." Impulsively she whacked her son on the back. "He sucked in a deep breath and started screaming. I cuddled him a lot and took him to the doctor."

The high Maori mortality focuses on babies of low birth weight born of young, smoking mothers. "The nicotine may keep the baby from growing," says Tonkin. Indeed, the same factors apply to SIDS deaths in other relatively low-income groups elsewhere. "But the association doesn't tell you what causes SIDS," Tonkin says. "Nobody knows that. And the haunting question is, when these babies get into difficulty breathing, why don't they wake up?"

AS YE ARE, so shall ye dream, says modern dream research. Men dream more often about other men than about women, who tend to dream of the sexes in equal proportions. Men are physically more aggressive in their dreams; women's dream aggressiveness tends to be verbal. Children often dream of frightening encounters with animals, the elderly of becoming lost.

An early hypothesis associated dreaming with mental health; popular magazine articles urged readers to "Dream and Stay Sane." With further research the hypothesis broke down. Dr. Gerald W. Vogel of Atlanta's Emory University School of Medicine even showed the reverse: Deprive a depressed person of REM sleep, when the most vivid dreams are said to occur, and the condition often improves.

For victims of nightmares the night is a time of torment. "The common thread among those who have nightmares frequently is sensitivity," says Dr. Ernest Hartmann, professor of psychiatry at Tufts University School of Medicine and director of two sleep centers in the Boston area. Advertising for subjects who had nightmares at least once a week, Hartmann found that many of the respondents were artists—painters, musicians, composers—followed in number by teachers and therapists.

"They were all very open and vulnerable," he said. "Most had had stormy adolescences, sometimes followed by bouts with depression, alcohol, and suicide attempts. They never considered therapy for their nightmares, and some said the dreams helped them in some way."

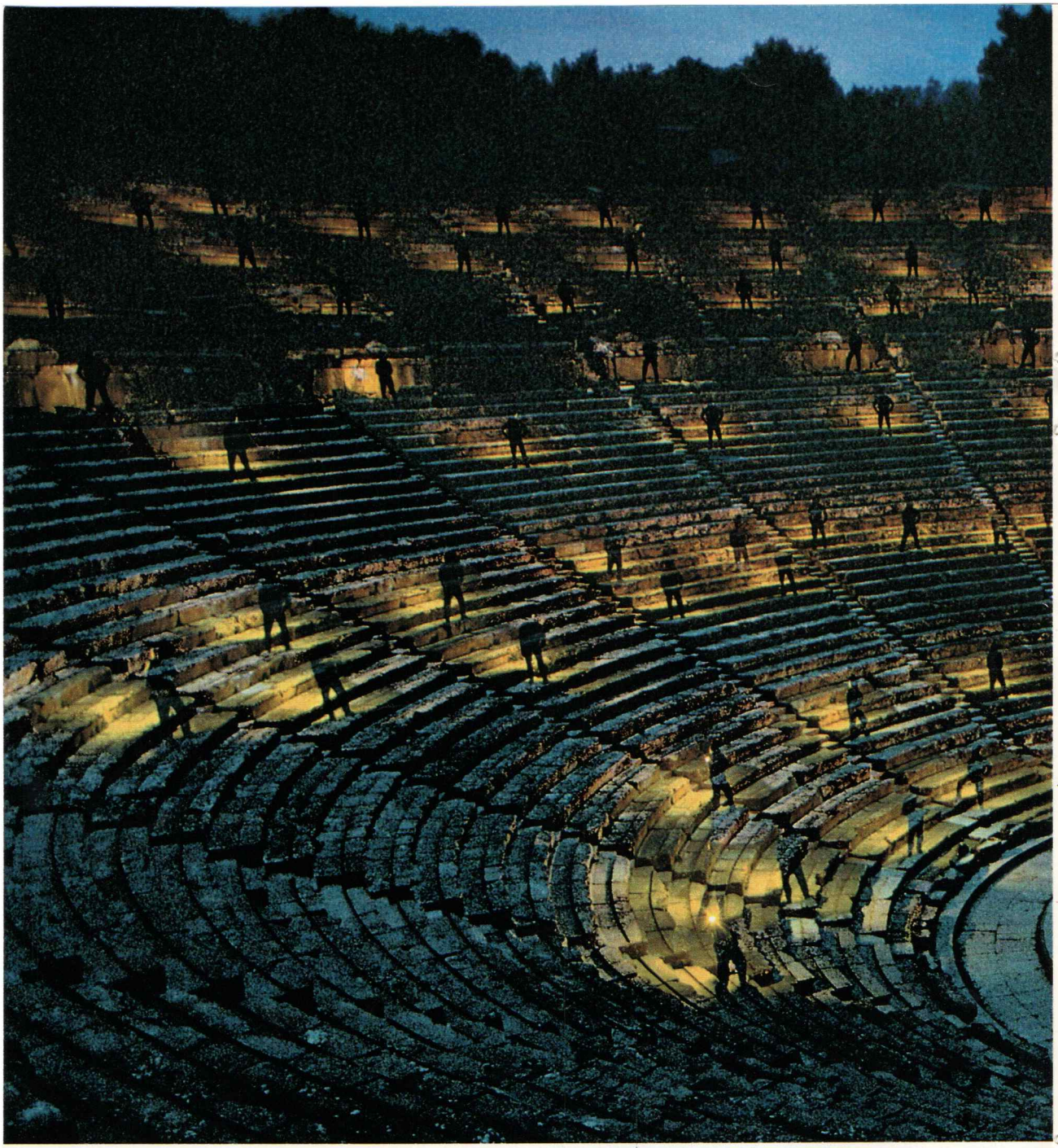
At the annual meeting of the Association for the Study of Dreams, I sought an explanation for an earlier dream that still brought the hair follicles on my forearms to prickly attention. My quest led me to Dr. Gayle M. V. Delaney, a dream psychologist and the first president of this group.

Gathering around a table with Delaney and her San Francisco colleague, psychiatrist Loma K. Flowers, I proceeded.

"It was night, and I was coming out of a dark place onto a screened porch. The porch took a 90-degree turn to the left into a long corridor. As I walked down the corridor, I began to hear a grinding, threatening noise emanating from a circular Thing at the far end. I felt it was evil, and I was terrified, but I was not going back to the dark place. I pressed forward, and the noise of the Thing grew louder and more threatening. I woke convulsively, my heart thumping." Follicles at attention, I leaned back and waited for the analysis.

Instead, Drs. Delaney and Flowers asked questions: Tell us more about the dark place. Did you look back at it? What did you see? What is a screen? What is a porch? What is a screened porch? How can a noise be evil? When I protested that everybody knows what a screened porch is, they replied they were from Mars and had never seen screened porches, dark places, or evil

PROBING MYSTERIES of the brain, pioneering neurobiologist Michel Jouvet explored the influence of neurons on sleep, suppressing the paralysis of REM sleep in a famous experiment on cats. Jouvet labels volumes of his scholarly papers with prints in his office at the Université Claude-Bernard in Lyon, France.



DIVINE HELP was invoked by the ancient Greeks for relief from insomnia and sickness. Hypnos, the god of sleep (right), was said to fan mortals with his wings to induce slumber.

Multiple images of photographer Louie Psihoyos, silhouetted by strobe flashes, fill the theater at Epidaurus, Greece (above), site of a shrine to Asclepius, god of medicine. Admired for its exquisite design and superb acoustics, the theater was built in the fourth century B.C. for the entertainment of the sick and lame during their convalescence. The complex at Epidaurus also included temples, baths, a gymnasium, and a stadium.

BRITISH MUSEUM

Asclepius was thought to work his cure during sleep. Appearing before his patients

in dreams, he mixed potions, applied bandages, and summoned sacred snakes to lick afflicted areas.

Shrines to Asclepius were found throughout ancient Greece. One of the largest, at Corinth, includes a museum displaying statuary of body parts offered to the god in thanks for his help in healing the specified area.

noises, and would I tell them what those things meant to me?

When I tried to answer their questions, my stomach tightened, and I yearned to be somewhere else. But a bargain was a bargain. As we proceeded, it became clear they were extracting the meaning of my dream from me. What emerged was concern about a job change many years ago, the fear of leaving a familiar but unpleasant old place for a terrifyingly new one.

"Nightmares can help us over stumbling blocks in our lives," Delaney explained. "They tease us into wanting to figure out things we can't confront when we're awake. The critical thing is what a symbol like the screened porch means to the dreamer. Little kids love it when we say we're from Mars. Then *they* get to tell us who the monster is." My own monster is on the shelf now, and the follicles stand at ease.

T' ingrave a Moon, or *Morpheus* is a Theam
With Artists common, as it is to dream.
But to Interpret Dreams (as here) doth passe
All Workes that ever have been cut in brasse.

THE 89
INTERPRETATION
OF
DREAMES,
Digested into five books by that
Ancient and excellent *Philosopher*,
ARTIMEDORUS.
Compiled by him in *Greek*; and translated afterwards into the *Latine*, the *Italian*, the *French*, and *Spanish*, Tongues.
And now more exactly rendred into *English*.
It being a work of great esteem in all Ages, and pleasant and profitable to peruse, for all conditions of people whatsoever.
In animum & mentem cum qua Dii nocte loquuntur.
Behold their minds with whom ith' dead of night,
Angels themselves to have discourse delight.
When good dreams fall, I do with Joy pursue them,
When bad ones fall, I pray I may eschew them.
The fourth Edition, newly corrected,
July 15 by the *French*, and *Latine* Copy.
LONDON,
Printed by *Bernard Alsop*, 1644

*DREAMS AUGURED THE FUTURE for Artimedorus, a second-century analyst. A 1644 edition of his book—*The Interpretation of Dreames*—bears a title similar to the dream tome of Sigmund Freud, who established psychoanalysis in Vienna during this century.*

Inviting patients to relax on his couch, shown here in London's Freud Museum, Freud viewed dreams as the "royal road" to understanding unconscious motivations. Some modern theorists hold the contrary—that dreams manifest random neural events, with little or no symbolism attached. BRITISH LIBRARY

Sigmund Freud, the Viennese father of psychoanalysis, saw dreams as safety valves whereby unconscious wishes could be disguised in symbols to guard sleep. Indeed, Freud felt that dreams provided the "royal road" to the unconscious.

For researchers at the Harvard Medical School, however, dreams result from interactions between neurons. Drs. J. Allan Hobson and Robert W. McCarley propose that brain-stem neurons become intensely active during REM sleep and bombard the cortex, the thinking part of our brains, with electrical signals. A dream ensues as the cortex tries to make sense out of this. The theory dispenses with the Freudian concepts of the unconscious and unsatisfied wishes—and with Freud himself—in our understanding of dreams.

Building on this theory of brain-stem activation, Nobel prizewinner Dr. Francis Crick, who helped describe the DNA molecule, and mathematician Dr. Graeme Mitchison challenge all current attempts at dream interpretation. They say that REM sleep refreshes the cortex by clearing overloaded circuits. REM sleep serves as a reverse learning mechanism: "We dream in order to forget."

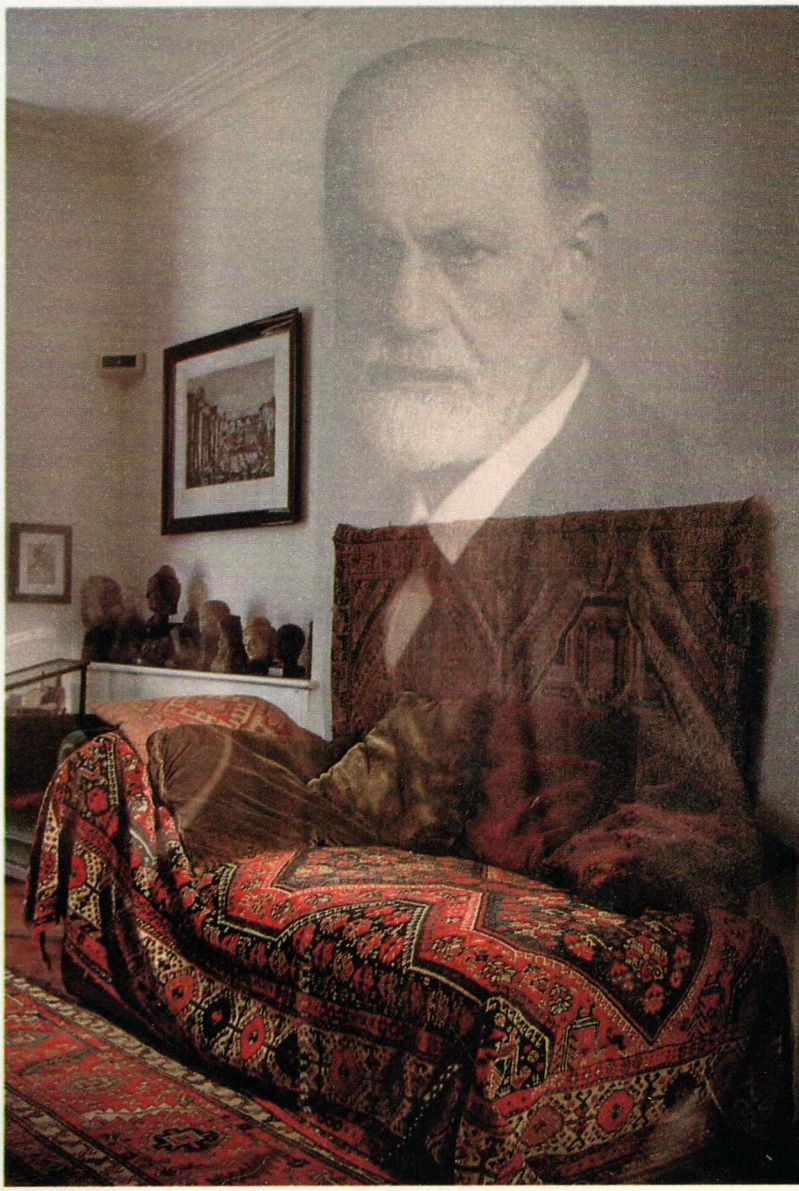
These are fighting words for dream psychologists, for there are no meaningful monsters in the theories. "I think they're wrong," says Dr. Ernest Hartmann. "Dreaming obviously involves an electro-chemical process, but there is no way that that makes dreams meaningless. There's no question that you can learn about yourself from your dreams."

Maybe we don't have to take sides in the argument. As a layman who dreams, I think Hobson and McCarley's idea provides, if not a royal road, at least a neural railroad track for dreams to travel. I would also like to think, with Crick and Mitchison, that evolution has fashioned a way for my brain to download the detritus of everyday experience. But I agree with Hartmann and others that monsters can be meaningful.

Dr. Stephen LaBerge, a psychologist at

Stanford University, deals with his monsters in person. Set upon by an ogre in a dream, he reports, he wrestled a bit and then, suddenly realizing that "the odious barbarian was part of myself, I told the ogre that I loved it."

LaBerge is a rare individual who often experiences "lucid" dreaming, the phenomenon of being aware that you are dreaming. To this he adds personal participation. He claims the technique has "significant potential for emotional healing, such as resolving a conflict with a loved one who has died," a view that evokes strong negative reactions from other dream specialists.



WHY do we sleep? Common sense tells us that it restores body and mind, or as Shakespeare put it, "knits up the raveled sleave of care." Scientists have trouble with this theory, because no one has convincingly demonstrated what is restored.

The answer from Circadia is that our body clock prompts sleep. True enough, but what controls the clock?

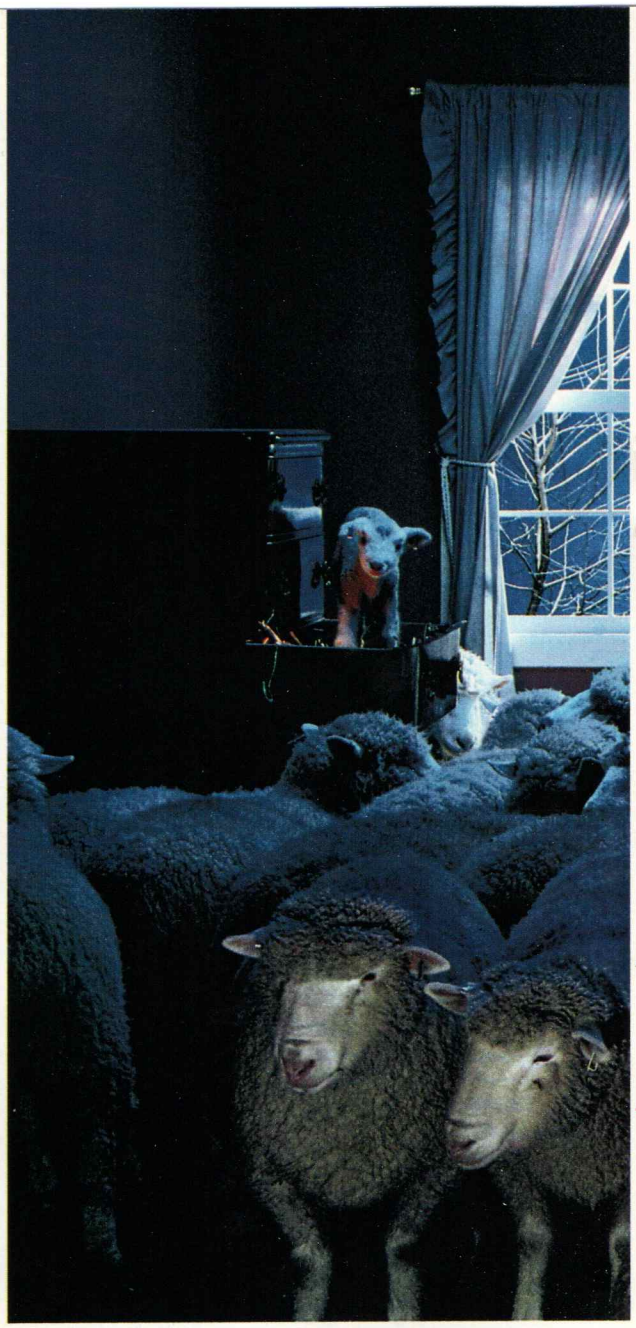
Biochemists postulate a sleep-inducing substance that accumulates during the day and finally puts us to sleep. It is a seductive hypothesis, and lots of people are working to find the elusive "hypnic" factor. Dr. Christian Guilleminault of the Stanford University Sleep Disorders Clinic says, "In theory, it is the holy grail of sleep research. Such a natural substance could result in the ultimate sleeping pill. But nobody has found it."

The answer from neurophysiology is that populations of neurons orchestrate the sleep process, and a leading investigator is a distinguished French neurobiologist who studies the nerve behavior of cats.

With the end of World War II Michel Jouvet, a French Resistance fighter, received a Fulbright scholarship to UCLA. He studied with researchers who were focusing on the reticular formation, a slender core of gray matter in the brain stem, to assess the neural basis of consciousness.

When Jouvet returned to Lyon, he began a historic series of cat experiments that began to pinpoint the locations of REM-inducing brain cells. By lesioning tiny colonies of brain-stem neurons, he produced insomnia in the cats and also suppressed the

REPETITION BREEDS RELAXATION for those who find routines such as counting sheep helpful in falling asleep. But why do we sleep? Despite all the testing, measuring, observing, and theorizing of researchers, the answer remains as elusive as a dream.



muscle paralysis that typifies REM—or, as he and other Europeans term it, paradoxical—sleep.

Jouvet's experiments have spurred other brain researchers in their quest to identify the neurons that control REM and non-REM sleep. But the tantalizing question of what it is that activates the REM neurons still drives Jouvet.

When I visited him in early May, the winds of a peculiar climatic condition known as les Saints de Glace—"the saints of ice"—chilled us as we climbed the steps to his office in the Université Claude-Bernard. "I thought I would understand the why of sleep by looking at the how of the neurons," said Jouvet, "but that did not tell me. So I am going back to study how sleep develops in humans and animals, and it is very critical because I am older, and I have much less time than before."

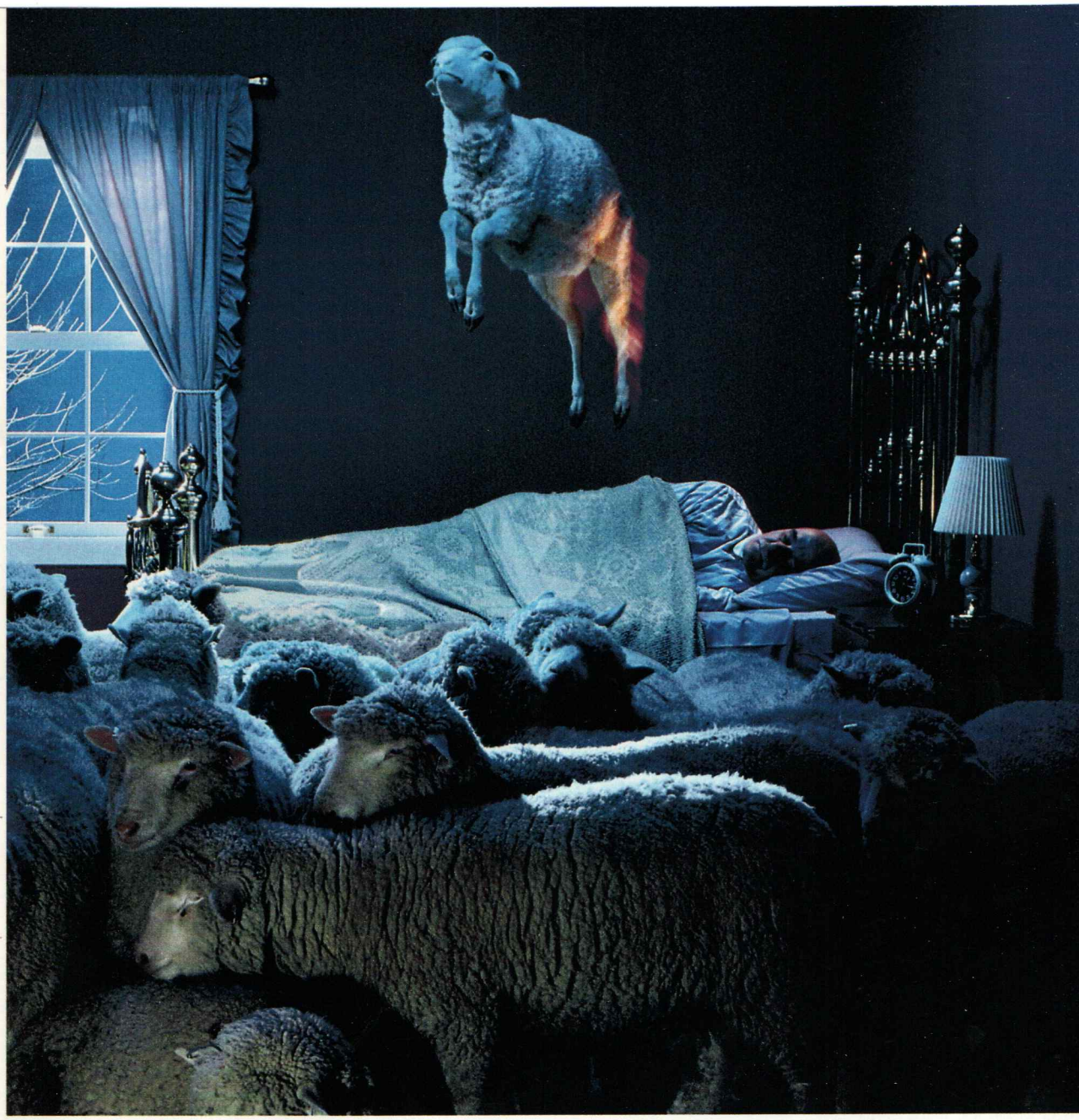
As we sat across the long table in his office, for the moment secure from the frosty breath of les Saints de Glace, Jouvet outlined his theory for paradoxical, or REM, sleep: to preserve differences in individuals.

"When I lesioned the cats' neurons," he continued, "and saw them acting out their dreams, I was very surprised by the differences in behavior. Each cat had its own repertoire of activity. And I started to ask, why are those small differences? My answer is that paradoxical sleep is the continuation in another form of the neural programming of individual differences in waking behavior."

If you are constructing a theory that says paradoxical sleep is essential, a mammal that gets along without it presents a challenge. Jouvet is therefore curious about the bottlenose dolphin, who with a couple of other species possesses the most unusual sleep rubrics in the animal kingdom. Soviet investigator Lev Mukhametov has demonstrated that bottlenoses sleep with only half of their brains at a time and never show paradoxical sleep.

"I have looked at his records, and it is true," Jouvet says, "the animals have no paradoxical sleep. I think the dolphin may possess the secret of sleep."

For Dr. Ralph J. Berger, a biologist at the University of California at Santa Cruz, sleep developed over the course of evolution as a way of conserving energy. "By turning down our metabolic thermostats, sleep reduces our need for food," he says. Berger believes that sleep and hibernation have a common evolutionary origin. Working with pigeons, he has demonstrated that withholding food prompts a state of torpor in



which a bird's body temperature and metabolic rate decrease.

THUS THE SEARCH for the secret of sleep continues—a search pursued with a lifetime of fervor by Dr. Allan Rechtschaffen of the University of Chicago in studies of crocodiles, rats, and humans. "Perhaps sleep does not have a function," he said. "Perhaps we should accept our failure to isolate a specific function for sleep as evidence for nonexistence of a function.

"But it is hard to believe that we spend almost one-third of our lives in a behavioral state that has no function at all. If sleep does not serve an absolutely vital function, then it is the biggest mistake the evolutionary process has ever made."

I look forward to the completion of the noble task these dedicated researchers have set themselves upon. Meanwhile, I will heed the simple but wise advice of Thomas Cogan, an Englishman and teacher, who in 1584 advised his students: "In sleeping and waking, wee must folowe the course of nature, that is to wake in the day, and sleepe in the night. . . ." □

Red Crabs

On the March on Christmas Island

ARTICLE AND PHOTOGRAPHS BY JOHN W. HICKS

A CASCADE OF CRITTERS turns the streets of Christmas Island red as 120 million forest-dwelling land crabs migrate en masse to seaside breeding grounds. Residents generally step aside for the crusty invaders—and keep their doors shut.

THE RED CRAB (Gecarcoidea natalis) shares its 135-square-kilometer home with 2,000 islanders and 14 other land crab species.

"JOHN, THERE'S A RED CRAB on your pillow," my wife called out from the bedroom, a touch of laughter in her voice.

It was a fitting introduction to Christmas Island. But the trespass strained our sense of humor a little, for we had just endured a rather tiring night flight from the Australian mainland.

We soon learned that at this season—late spring in the Southern Hemisphere—the intrusion was an everyday occurrence. The bright scarlet crustacean was just one of an estimated *120 million* of its kind swarming on their spectacular once-a-year breeding migration within a few kilometers of the front door we had inadvertently left open.

Lying in the Indian Ocean 360 kilometers (220 miles) south of Java, the Territory of Christmas Island has a tropical, but not too sticky, climate. Chinese, Malays, and Europeans make up its population of 2,000.

Rugged limestone cliffs border most of Christmas Island's forbidding coastline. Toward the interior the land rises staircase-like in narrow terraces and cliffs to a broad plateau about 200 meters above sea level. Rain forest, nurtured by annual rainfall of 2,000 millimeters (78 inches), still covers three-quarters of the 135-square-kilometer island even after a century of settlement.

Though most of Christmas Island's people are connected with mining phosphate for fertilizer, I came there to work for the Australian National Parks and Wildlife Service in its newly established Christmas Island National Park and to provide conservation assistance to the island administration.

Like other residents we lived in the northeast corner of the island. Our village, Drumsite, stood on the plateau. On the lowest, shoreside, terrace lies the chief community, simply called the Settlement.

Christmas Island ranks as one of the world's great seabird habitats. Eight kinds breed there, including Abbott's booby, the Christmas Island frigatebird, and the beautiful golden bosun bird; these three breed nowhere else on earth.

Even more arresting, though, are the land crabs. Fifteen species dwell there, including the giant robber, or coconut, crab, the largest land crab on earth, which can weigh up to three kilograms, or nearly seven pounds.

Smaller but vastly more numerous is the land-dwelling red crab of Christmas Island. That population count of a staggering 120 million adds up to more than 8,000 metric tons of crabs. Near year's end, when the rainy season comes, the red crab begins its annual breeding migration from inland forest plateau down to the sea, a vast red tide flowing over the land. Found everywhere, from the highest terrain to the coastal shores, the bright red crustaceans are difficult to ignore.

"I can't get over the fact that one can walk so unhampered through the jungle," an English friend wrote after visiting the island. "You have those useful little crabs keeping everything tidy." Indeed. With more than one red crab per square meter busily eating fallen leaves, fruits, and flowers, the rain-forest floor usually appears swept clean.

In the dry season, the treetop canopy thins out. Less shade and lower humidity keep the crabs in their burrows, and leaf litter accumulates on the ground. The crabs can survive for several months without surfacing, often concealing their burrows with plugs of dried leaves.

Given the choice, red crabs seem to prefer green leaves to dead ones. But they are not strict vegetarians. They won't pass up giant African snails and dead seabirds. One red crab was seen nibbling at the butt of a discarded cigarette, smoke still curling from the other end.

With a biomass of nearly a ton per hectare, red crabs are probably the main decomposers in the rain-forest ecosystem, recycling nutrients locked in fallen vegetation. Their cylindrical brown droppings are scattered in heaps on the ground, like fertilizer pellets—which they are—and their burrowing tills the soil.

The red crab migration down to the shore lasts 9 to 18 days—a time to keep your doors shut. The crabs flood across the roads and through settled areas. Mining traffic and residents' automobiles take a deadly toll. Tracks the phosphate trains run on present a

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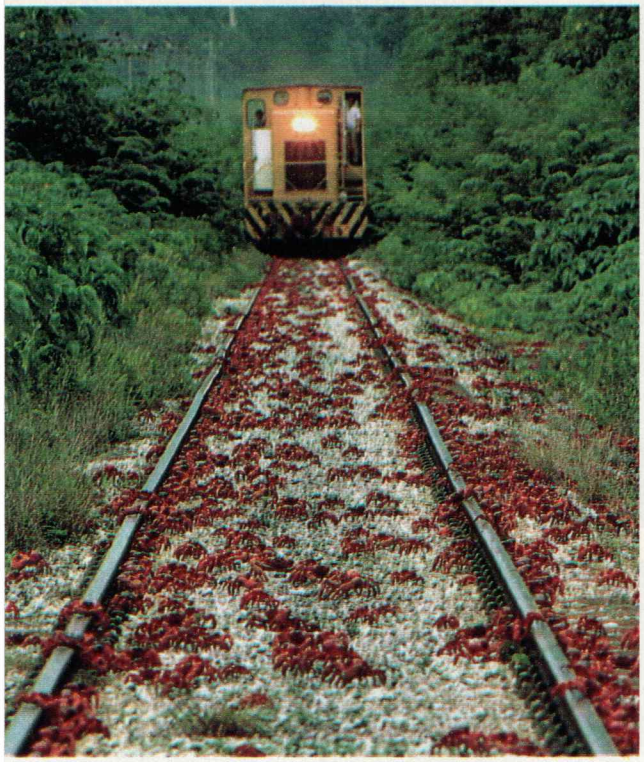
John Hicks served as government conservator for the Australian National Parks and Wildlife Service on Christmas Island from 1979 to 1983. At present he is conservator on Australia's Norfolk Island.

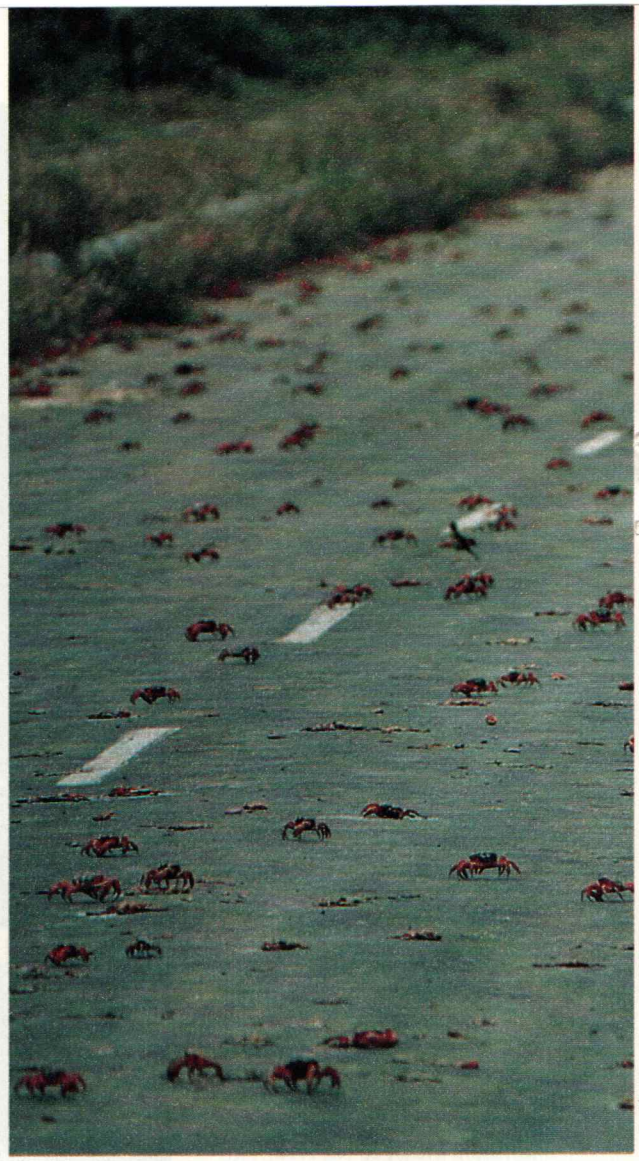
ROGER GARWOOD (ABOVE)

A CRAB'S BEST FRIEND during its annual migration is anyone willing to give it a good soak—no small favor to the crustacean, which must keep its gill chambers moist to survive. The red crab waits until the arrival of the rainy season in late October or November, then travels during morning and late afternoon to avoid the heat of the day. Even so, many crabs dry out and die during the six-week round-trip migration.

Back home in the plateau rain forest, red crabs keep their neighborhood relatively free of litter (bottom) by feeding on leaves and other material. Debris accumulates (top) when crabs take to their moist burrows during the dry season.

THE PERILS OF TRAVEL claim a million crabs during migration. Many die of heat stress as they climb over hot railroad tracks—the route used to transport phosphate, the island's only export. The largest number die while crossing roads, their sharp claws occasionally puncturing the tires that crush them. "People avoid driving because of the crabs," says the author. Putting goes on despite them.





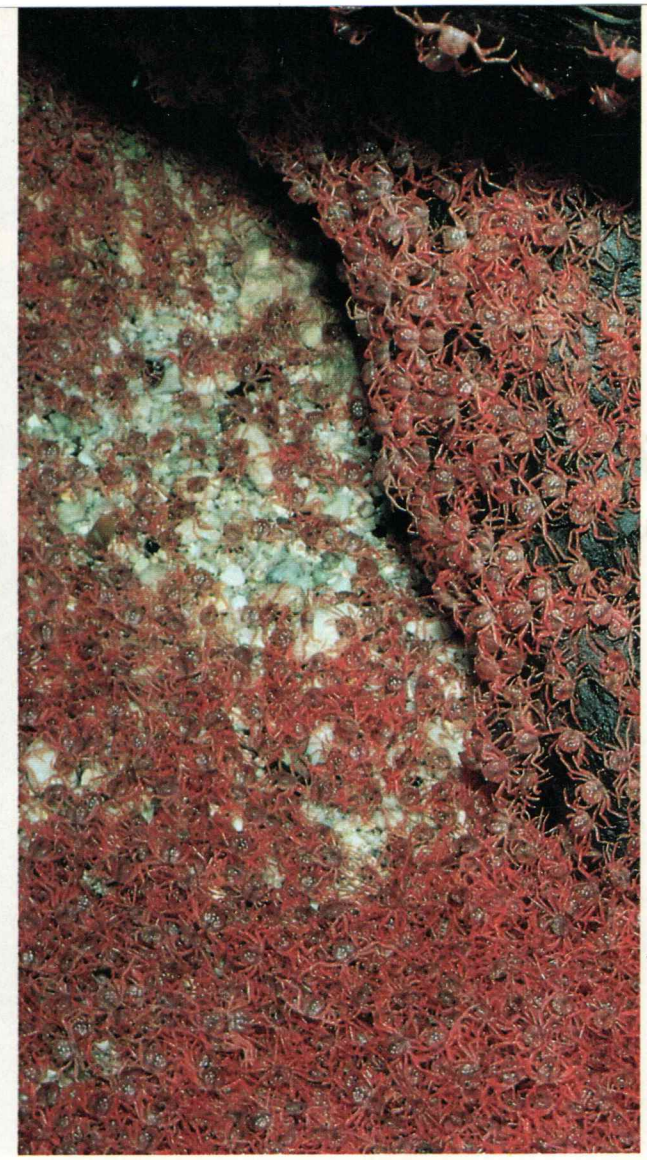
lethal barrier. The sunbaked rails kill as many as 100,000 crabs each year, probably from heat stress. The carnage doesn't seem to affect the survival of the species; nearly a million crabs are killed in each migration, but that is less than one percent of the adult population.

WHEN I STARTED my observations, the timing of the red crab breeding migration was something of a mystery. Although it was linked to the start of the wet season, a more precise pinpointing had not emerged. Finding references to lunar rhythms in spawning migrations of other land crab species, I matched past lunar cycles with records of dozens of red crab migrations. A beautiful pattern emerged: In all but one migration, egg-bearing crabs were first seen on the shore terrace within three days of the last quarter of the moon.

Large male crabs lead the downhill migration, with females gradually forming a greater proportion of the march and dominating its later stages. Those early crabs—big ones, measuring as much as a hundred millimeters across the carapace—probably are more than 12 years old. Smaller and younger crabs bring up the rear.

The wave of crabs moves hesitantly down toward the sea, traveling in the morning and late afternoon. The large males reach the sea in five to seven days, followed a day or so later by the females and smaller crabs. At times the shoreline is red with crabs soaking up seawater to replace moisture and salts lost in the strenuous journey. Most simply lie on

ALL BY ROGER GARWOOD



MISSION ACCOMPLISHED: A female, claws upraised, empties her brood pouch into the sea (above). About 12 days earlier she entered a male's oceanside burrow, where the pair mated. The survivors among her 100,000 larvae will return to shore in the megalopic stage (bottom left). There they metamorphose into tiny crabs (bottom right), born travelers that begin a nine-day journey to the plateau (right).

damp sand or wet rocks, absorbing water through hair-lined holes at the base of the body. Others are doused by waves or dip themselves in tidal pools. A few drink daintily, spooning water to their mouths with alternating claws.

MALES THEN RETREAT to coastal terraces to build burrows and argue about their ownership. Evenly matched males may fight for as long as ten minutes—occasional fatalities resulting more from heat stress than wounds. Soon the terraces resemble miniature goldfields, pocked by burrows with piles of excavated dirt at the entrances. The females come to join their mates.

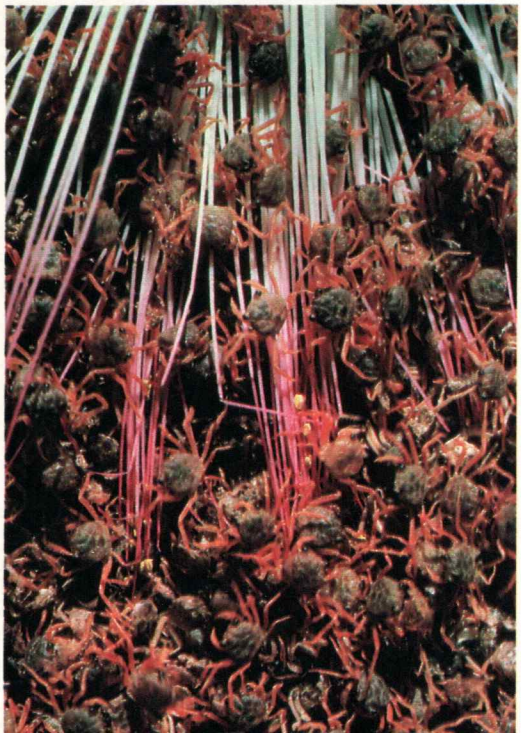
Mating usually occurs in the privacy of the burrow. Afterward, the male emerges to take one last dip in the sea before the strenuous uphill trek to the plateau rain forest.

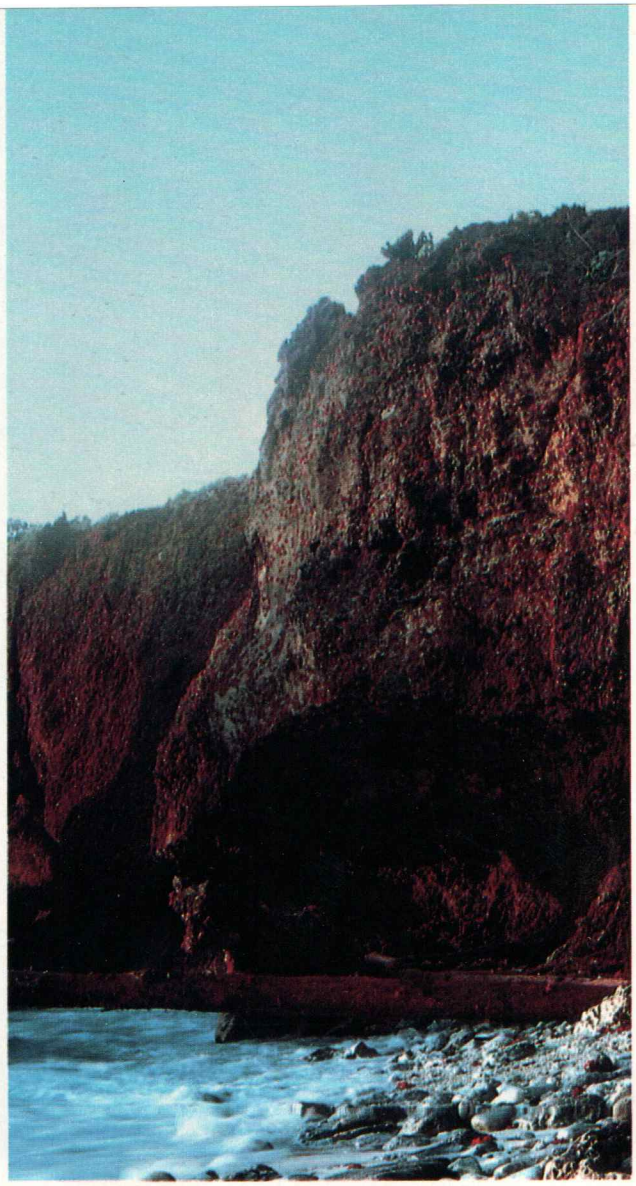
The female remains in the moist burrow for another 12 days or so while the eggs develop. The thousands of eggs are tucked into a brood pouch between her extended abdomen and her thorax.

Then the berried (egg-laden) female heads for the shoreline. Females pack into shaded areas, often piled atop one another with as many as a hundred per square meter. Collectively they make a peculiar squeaking noise, like the faint cries of young birds.

The crabs release their young at night, near high tide, and that activity is marked by an uncharacteristic recklessness. For although the females crawl cautiously to the water, they enter it with a rush.

Their bodies propped upright, the crabs





HOMEWARD BOUND, an army of female crabs scale a cliff after releasing their larvae. Others, unable to reach the water, have precariously dropped their young from above. The whole migration, says the author, is "like an enormous, rustling red carpet. You can hardly believe your eyes."

engage in a short, vigorous bout of body shaking and abdomen flexing to break open the eggs in the brood pouches. Often they lose footing in the surf and are swept about. Where the shores are precipitous, many females have to drop their young from cliff faces as high as eight meters above the water. A number lose their grasp and fall; the base of a cliff may be littered with corpses. Moving above the waterline, the females brush away the egg remnants. Then, with egg pouches clean, they begin the long crawl home, which lasts from four days to a week.

Release of the young continues for five or six nights, when clouds of larvae can be seen near shore.

The larvae spend about 25 days in the sea, returning close to shore at the megalopic (large-eyed) stage. The tiny megalops don't look like crabs yet, for their abdomens are extended like those of shrimp. A person swimming nearby can find it a prickly business, with hordes of crab larvae settling on his skin. But soon the megalops metamorphose into young crabs. They leave the water when they are about five millimeters (one-fifth of an inch) across.

Many years, for reasons not yet understood, no new crabs emerge. But in good years, when the tiny crabs come ashore by the millions, they overwhelm the Settlement. They climb walls, squeeze under doors, and crawl through windows. Once inside, they'll get into toilets, lampshades, and a hundred other places.

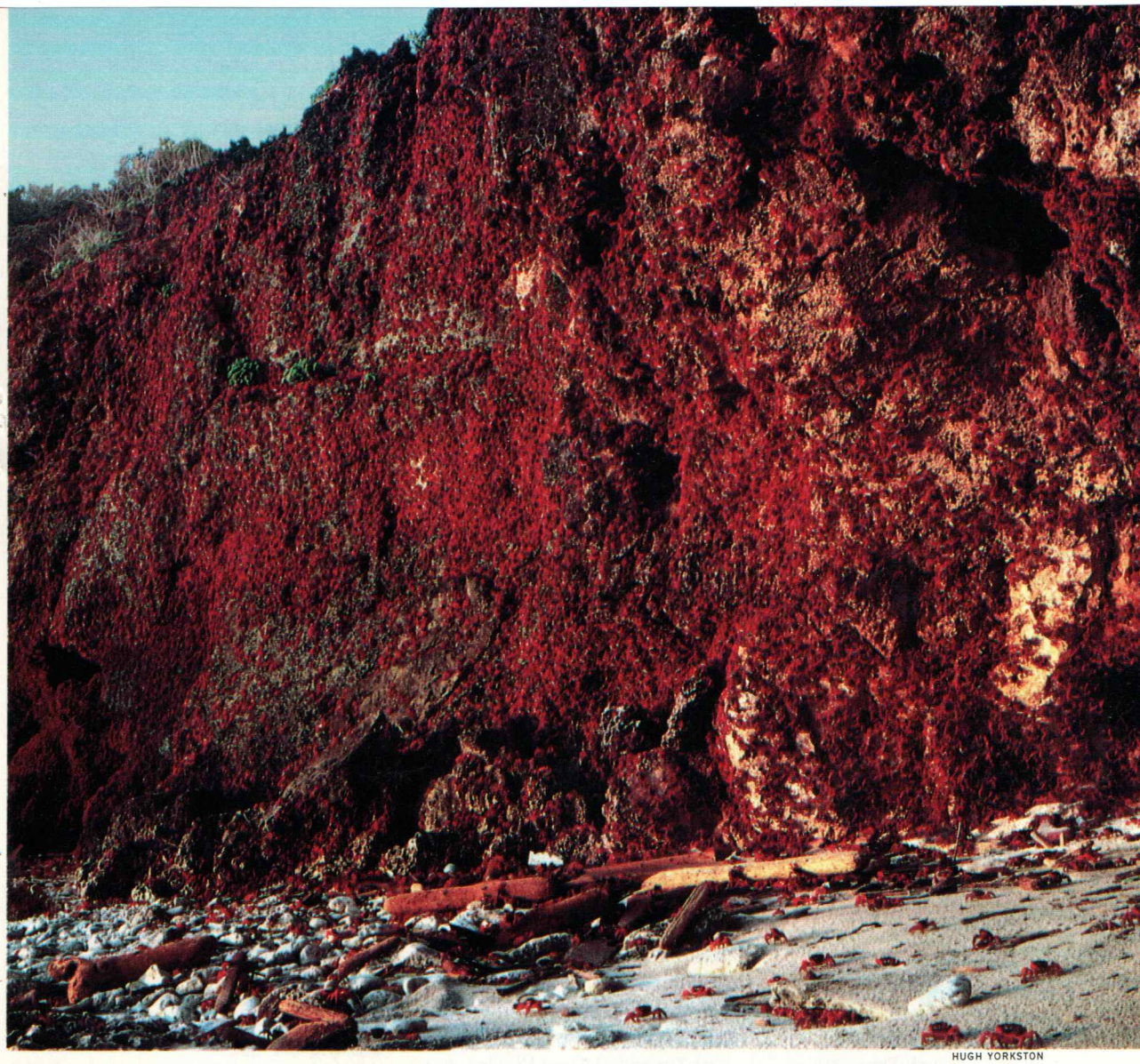
Life is an uncertain thing for a baby crab. Many are crushed by cars during the inland march. The reef heron and island thrush may prey on them, and it seems likely that many of the other land crab species on the island exploit this vast food source.

Once inland, baby red crabs do their best to keep out of sight. Only by digging or searching through the forest litter can they be found.

Natural hazards for adult red crabs are surprisingly few. Moray eels attack dipping crabs occasionally. Robber crabs take some, particularly females with eggs; they have been known to dig up burrows and eat the occupants. Fortunately for red crabs, they do not appeal to human taste.

ISOLATED CHRISTMAS ISLAND, until it was finally settled in 1888, was one of the few sizable tropical islands that had never been inhabited. The occasional ship stopping by to take frigatebirds and robber crabs for provisioning had little impact on the island's ecology.

In the last quarter of the 19th century Sir John Murray, a naturalist who had participated in the *Challenger* oceanographic expedition, arranged for rock samples to be



HUGH YORKSTON

collected from Christmas Island. Analysis confirmed that the place held rich phosphate deposits. But, while directing the exploitation of the phosphate, Murray furthered understanding of the island's unique biological features.

With the phosphate industry came inevitable changes. Two endemic species of rats became extinct. A few exotic plants and animals were introduced. And over the years the strip mining has brought about the removal or modification of a quarter of the island's forest, unfortunately including some of the preferred nesting habitat of the endangered Abbott's booby. Measures are now being taken to protect all seabird species. Most wildlife is now legally protected and guns are banned.

Long-term survival of Christmas Island's unique ecosystem will depend, of course, on wise land use. With phosphate mining winding down, plans are developing for a tourist industry on the island. Certainly the phenomenon of Christmas Island's fascinating red crab hordes would be a prime attraction for visitors.

Recent moves have been encouraging—the expansion of the national park to encompass 18 percent of the island area, a major study of Abbott's booby, and tightening of environmental controls.

A century ago Sir John Murray balanced an entrepreneurial flair with deep appreciation of Christmas Island's natural qualities.

Let us hope that modern men are just as wise. □

Key to '87

FROM HIGH ANDES to low prairie, from gray whales to red crabs, from ice to air—to know where we've been and when we were there, consult this key to the past year.

SIX-MONTH INDEXES ARE FREE upon request. The January-June index (Vol. 171) is available now; July-December (Vol. 172) will be ready in January. Write to National Geographic Society, Washington, D. C. 20036.

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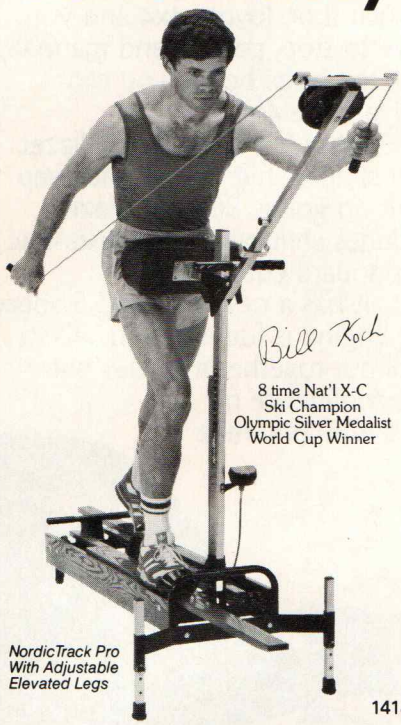
Scientific study ranks NordicTrack #1

Cardiovascular Exerciser



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Scientific abstract available upon request

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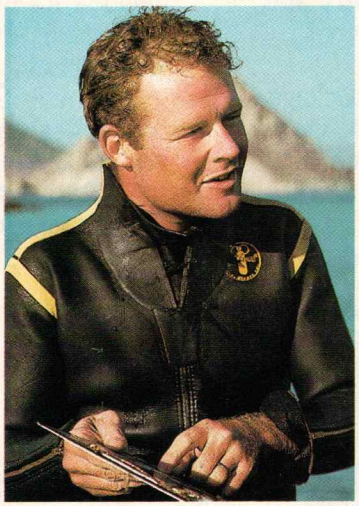
THE Heartbeat OF AMERICA TODAY'S CHEVY TRUCK

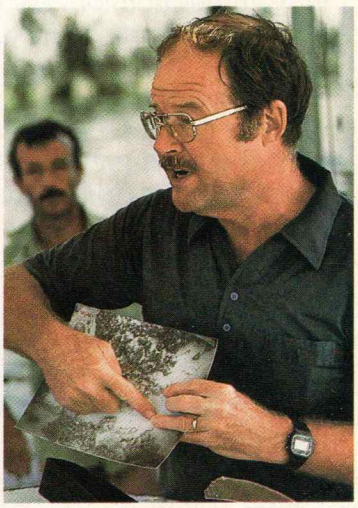
On Assignment

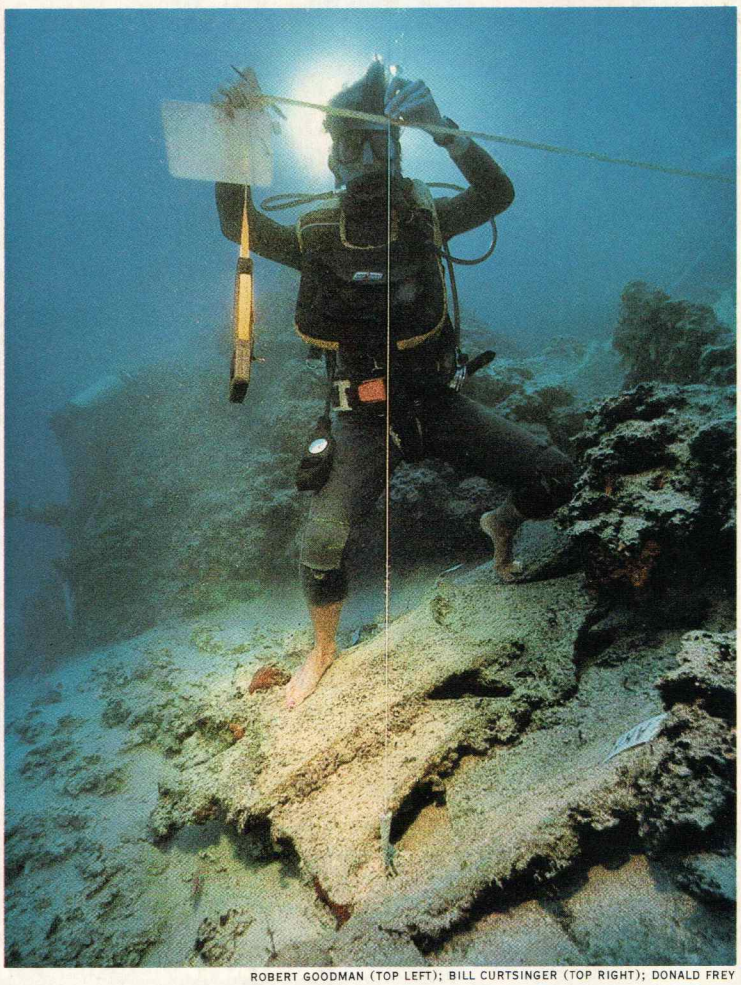
ONLY YESTERDAY, it seems, a youthful archaeologist named ***George Bass*** (right) directed his first seabed excavation for the Society, that of a Byzantine vessel off Turkey. That was in 1961. More than 25 years later, George is still going strong (far right). His latest excavation, of a ship lost in the 14th century B.C., is the oldest wreck yet found. Its cargo included copper ingots, such as those plotted by ***Dr. Faith Hentschel*** (bottom). Our long and productive partnership with George is underscored by his 16th Society research grant.

George earned his doctorate in classical archaeology from the University of Pennsylvania, where he was a professor from 1964 to 1973. He then founded the Institute of Nautical Archaeology (INA) "to tell the story of ships and shipping. My wife, Ann, and I sold everything except my library and her baby grand piano to set up headquarters on Cyprus." In 1976 the INA moved to Texas A&M University, where George is Abell Professor of Nautical Archaeology.

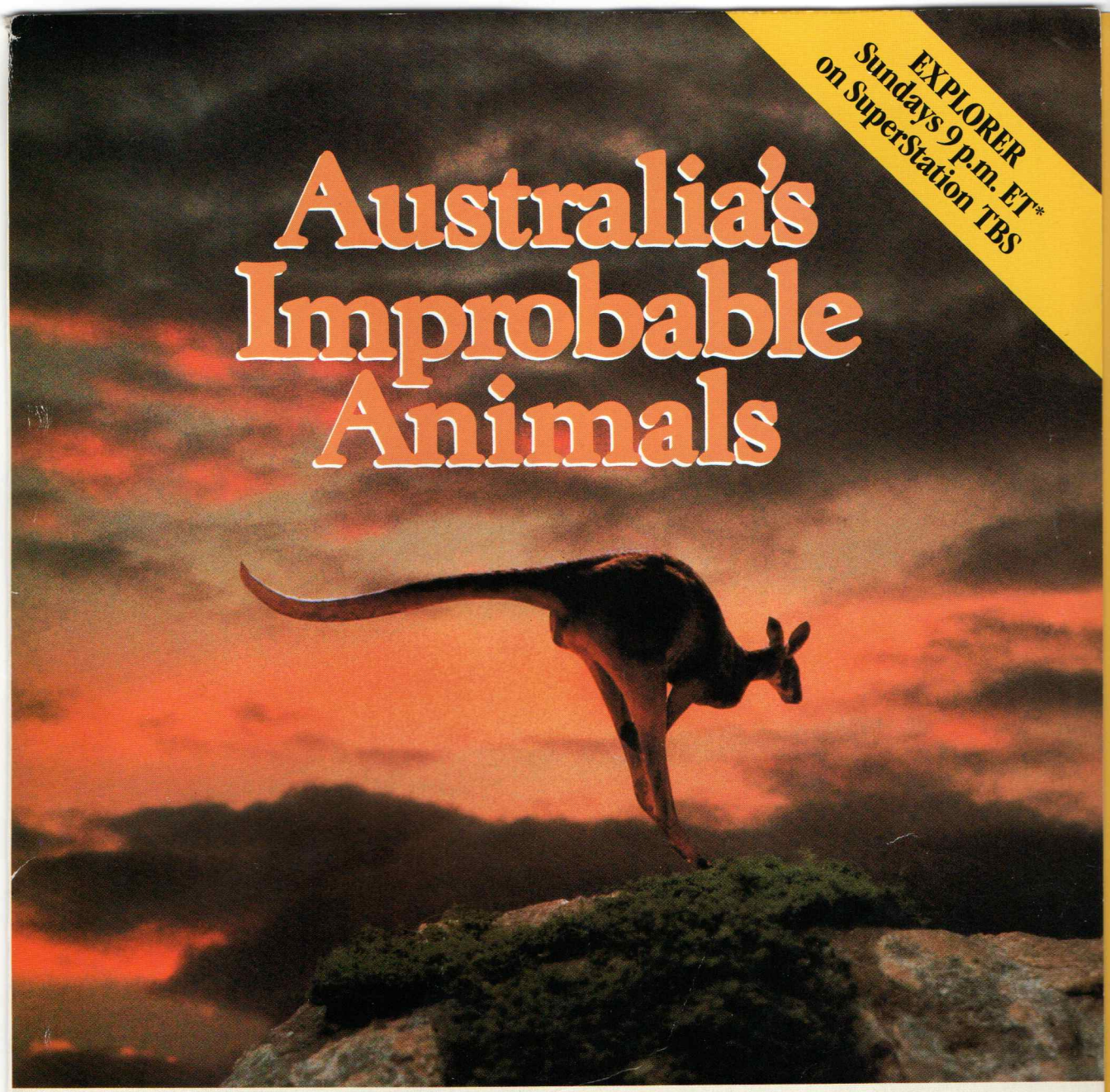
In some 1,700 dives his mishaps have been few. Once, 150 feet deep, he ran out of air. "I was sure I was going to drown. But as I clawed my way to the surface, a Turkish friend grabbed me and gave me air." George and three colleagues are now building houses in a Turkish olive grove on the Mediterranean, an old sea with tales yet to tell.







ROBERT GOODMAN (TOP LEFT); BILL CURTSINGER (TOP RIGHT); DONALD FREY



Tune in Sundays in December and travel to the land "down under." This month's four-part series will introduce you to strange and exotic creatures that have evolved over millions of years on the isolated island-continent of Australia. See kangaroos, koalas, and more in *Australia's Improbable Animals.*

December 6—The discovery of Australia and its curious animals.
December 13—Trace the evolution of Australia's wildlife over millennia.
December 20—Descendants of prehistoric animals adapt to extreme habitats.
December 27—Survey the impact of human settlement on Australia's wildlife.

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